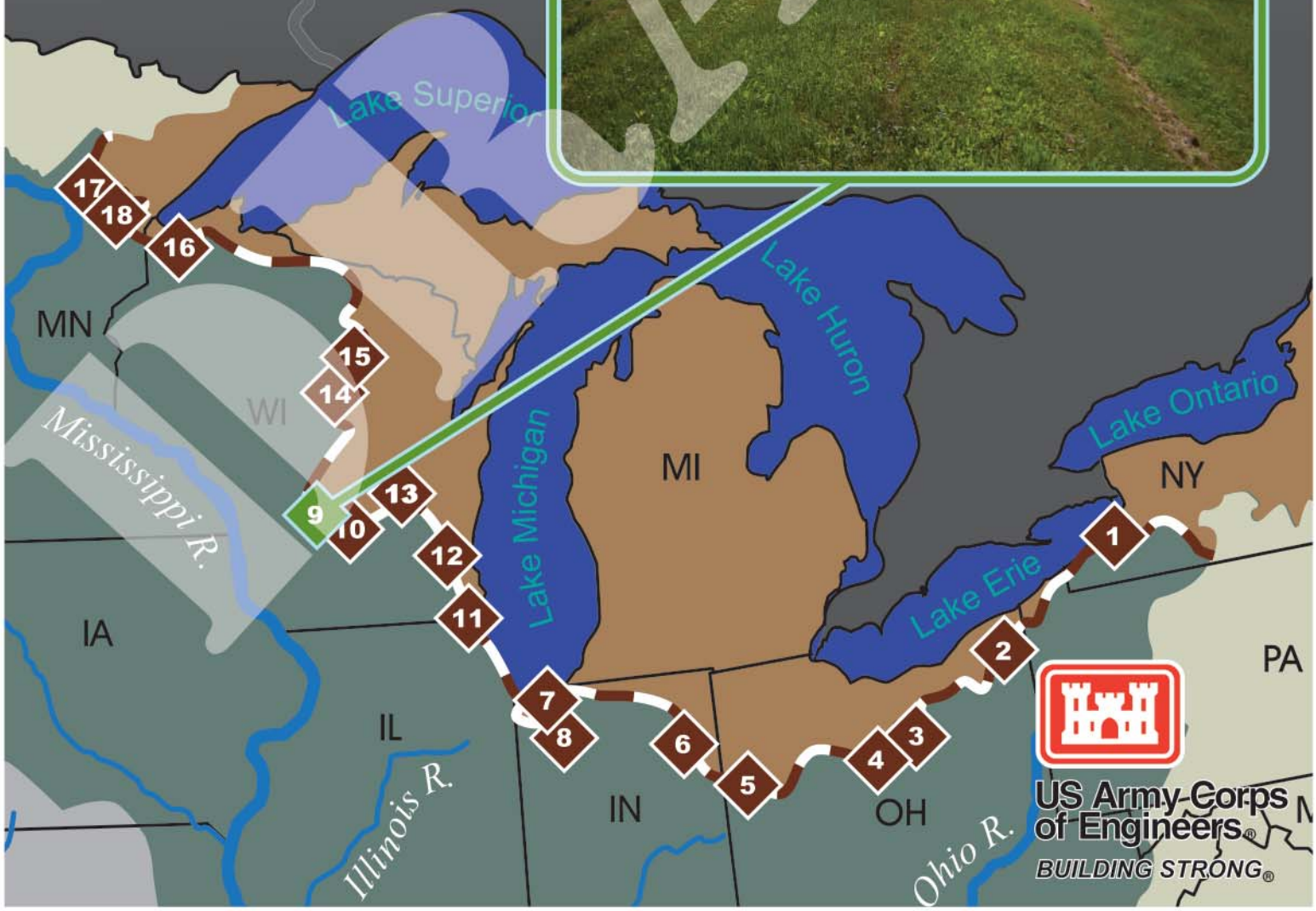
GLMRIS

Great Lakes and Mississippi River Interbasin Study

Aquatic Nuisance Species | Ecosystems | Navigation | Recreation | Flood Risk Management | Water Use

Focus Area 2 Aquatic Pathway Assessment Report

Portage Upstream, Wisconsin



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Executive Summary

This assessment characterizes the probability of Aquatic Nuisance Species (ANS) spreading between the Great Lakes and Mississippi Rivers Basins through any of three locations upstream of Portage, Wisconsin along the Wisconsin River. This was accomplished by evaluating the hydrologic and hydraulic characteristics of the site based on readily available information, and conducting a species-specific assessment of the abilities of potential ANS to arrive at the pathway and cross into the adjacent basin. The upstream Portage area consists of three discrete locations where interbasin flow may occur. The Portage area has historically been an area with high potential for interbasin exchange of water. Early settlers recognized this and actually established a navigable waterway and lock and dam system between the Fox and Wisconsin Rivers.

This site was determined to be capable of conveying surface water across the basin divide for floods slightly greater than a ten percent annual recurrence interval event. Significant rates of interbasin flow can occur at this location from the Mississippi River Basin to the Great Lakes Basin during larger flood events (e.g. 2,900 cubic feet per second (cfs) or 82 cubic meters per second (cms) for a two percent annual recurrence interval event). Since 1935, eight floods on the Wisconsin River have exceeded the ten percent recurrence interval event flow at this location. On average, flows that could have passed the divide into the Great Lakes Basin lasted about three days for each event, and ranged from one to six days. Thus, the Portage Upstream pathway was given a “medium” rating for the probability of an aquatic pathway existing at this location and being able to develop hydrologic conditions that could possibly facilitate the spread of ANS between the basins.

After establishing where aquatic connections exist or may form at Portage Upstream, the aquatic pathway viability for specific ANS of concern was then evaluated by looking at the biological requirements and capabilities of the 13 ANS listed in the table above.

The Portage Upstream location is located well downstream of the headwaters of the Wisconsin River and carries a large amount of flow (base flow of about 5,000 cfs (142 cms)). This presents a unique opportunity for any ANS established upstream of this pathway to be passively carried over the divide from the Mississippi River Basin to the Great Lakes Basin during flood events. Aquatic habitats upstream of this pathway on the Wisconsin River are high in diversity and quality, providing an opportunity for most ANS to find suitable habitat to colonize and act as a continuous source population to possibly take advantage of intermittent flood events. However, the Prairie du Sac Dam, which is located downstream on the Wisconsin River, currently functions as a permanent barrier to upstream movement of ANS and none of the ANS that are established in the Mississippi River Basin are currently known to exist upstream of the Prairie du Sac Dam or the Portage Upstream pathway. Thus, the probability of a viable aquatic pathway that would enable transfer of ANS across the divide at this site from the Mississippi River Basin to the Great Lakes Basin has been rated “low”. If one or more of these species were to become established upstream of this dam in the future, this rating would increase.

The only ANS that received a rating higher than a "low" was viral hemorrhagic septicemia virus (VHSv). VHSv

Aquatic Nuisance Species of Concern

Species	Common Name
Hypophthalmichthys molitrix	silver carp
Hypophthalmichthys nobilis	bighead carp
Mylopharyngodon piceus	black carp
Menidia beryllina	inland silverside
Channa argus	northern snakehead
Gasterosteus aculeatus	threespine stickleback
Gymnocephalus cernua	ruffe
Proterorhinus semilunaris	tubenose goby
Novirhabdovirus sp.	viral hemorrhagic septicemia virus (VHSv)
Apocorophium lacustre	a scud
Landoltia (Spirodela) punctata	dotted duckweed
Murdannia keisak	marsh dewflower
Oxycaryum cubense	cuban bulrush

currently established in the Great Lakes Basin and was rated as having a “medium” likelihood of transfer across the basin divide into the Mississippi River Basin. Thus, it was determined that there is a “medium” overall aquatic pathway rating at the Portage Upstream location, and only toward the Mississippi River Basin. Any potential for ANS to reach this basin divide location by non-aquatic vectors is a separate pathway that did not factor into the overall rating of this site.

There are two main data gaps that exist at this location. First is a lack of detailed topography at the divide. Detailed topographical data would enable one to identify the presence or absence of a defined channel during flood events and the depth of open water habitats. This would help determine the ability of fish to swim through this area or survive in the limited open-water areas on the divide. Second, a lack of a continuous monitoring program in the large upstream area of the Wisconsin River. A monitoring program would provide more detailed information to help determine the presence or absence of ANS upstream of the Portage location, and the areas upstream of the Prairie du Sac Dam on the Wisconsin River.

The most notable opportunity for reducing the potential for ANS transfer at this site would be the construction of a physical barrier by either raising the Lewiston Levee or by constructing a similar physical barrier to prevent flow across the divide.

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Acronyms

ANS . . . . . Aquatic Nuisance Species
ANSTF. . . . Aquatic Nuisance Species Task Force
BFE . . . . . Base Flood Elevation
CAWS . . . . Chicago Area Waterway System
CEQ. . . . . Council on Environmental Quality
CMP. . . . . Corrugated Metal Pipe
DEM. . . . . Digital Elevation Model
FEMA. . . . . Federal Emergency Management Agency
FIS. . . . . Flood Insurance Study
GIS . . . . . Geographic Information System
GLB . . . . . Great Lakes Basin
GLFC. . . . . Great Lakes Fishery Commission
GLMRIS. . . Great Lakes and Mississippi River Interbasin Study
HUC. . . . . Hyrdologic Unit Codes
INDNR . . . . Indiana Department of Natural Resources
MNDNR . . . Minnesota Department of Natural Resources
MRB. . . . . Mississippi River Basin
NAS . . . . . Nonindigenous Aquatic Species
NCDC . . . . National Climatic Data Center
NEPA . . . . . National Environmental Policy Act
NOAA. . . . . National Oceanic and Atmospheric Administration
NRCS . . . . Natural Resources Conservation Service
RCP . . . . . Reinforced Concrete Pipe
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 of 2007, and therein, it prescribes the following authority to the Secretary of the Army and the U.S. Army Corps of Engineers (USACE) (WRDA, 2007).

> *"(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 Portage Upstream location, in Columbia County, Wisconsin. This location is one of 18 locations identified in the Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization, (USACE 2010) as a potential aquatic pathway between the Great Lakes and Mississippi River Basins other than the Chicago Area Waterway System (CAWS). 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 kilometer) 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. The Portage Upstream, Wisconsin location is shown as location 9 in south-central Wisconsin.

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 several aquatic nuisance species (ANS) of concern, however, the proximity of Asian carp in the Mississippi River Basin to the basin divide near two locations lend 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 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 qualitatively estimate the likelihood that a viable aquatic pathway exists at the Portage Upstream, Wisconsin location 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) by including the following:

- A definitive determination of whether the Portage Upstream location should be included in the inventory of locations where a viable

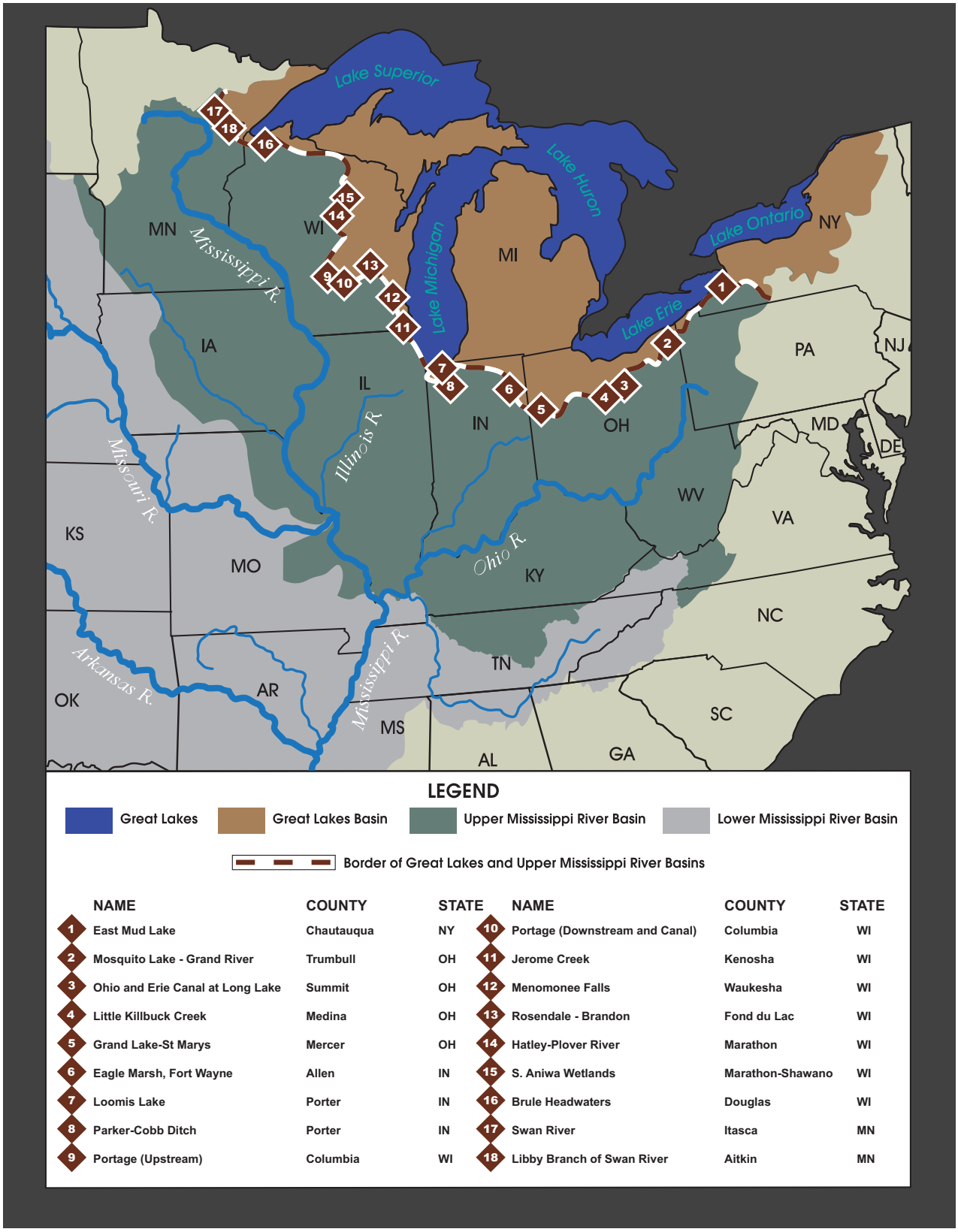

Figure 1. Potential aquatic pathway locations identified in the GLMRIS Preliminary Risk Characterization Study (USACE, 2010).

surface water connection between headwater streams on both sides of the drainage divide exists or is likely to form between the Great Lakes and the Mississippi River basins;

- A standalone report that characterizes the probability of aquatic pathway formation and the probability of interbasin spread of applicable ANS via the potential aquatic pathway at the Portage Upstream location;

- Development of clear problem statements that frame the means, constraints, and likelihood of the interbasin spread of ANS via the potential aquatic pathway at the Portage Upstream location; and

- 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 Portage Upstream location.

1.2 Summary of 2010 Preliminary Risk Characterization for Portage Upstream, WI.

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 Portage Upstream pathway as a location where there is a near term risk for the interbasin spread of ANS, there was some uncertainty with this rating.

This was mainly due to the presence of interbasin flow, the connection of inundated areas of the Fox and Wisconsin Rivers in hydrologic modeling at the one percent recurrence interval flood event, and the lack of readily available hydrological evidence found during the preliminary study effort to discern the relative frequency and potential magnitude of any aquatic pathway at Portage Upstream.

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 is a rainfall event that has a one percent probability, one recurrence interval 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 return recurrence interval (formerly referred to as a ten year event) is a smaller event that has a one in ten recurrence interval 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 recurrence interval of being exceeded in any given year.

The preliminary effort recommended that a more detailed assessment be conducted at this location. This was subsequently done in collaboration with the Wisconsin Department of Natural Resources (WDNR), USFWS, USGS, and other government agencies. The following actions were taken:

- Federal, State, and local stakeholders (i.e., USGS Water Science Office, WDNR Division of Water, county officials, and or local NRCS representatives) were briefed on the preliminary risk characterization results. Detailed site visits to observe potential connection locations were 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.

- Habitat and abiotic conditions in proximity to the location were analyzed relative to the needs and preferences of ANS in proximity to each location.

- The aquatic pathway viability and assessments of the likelihood of interbasin spread for each of the ANS of concern were revised based on the new information.

- Measures that could be implemented at the local or state level were identified to mitigate the likelihood of ANS spread across the Mississippi River Basin-Great Lakes Basin divide.

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. The results of this assessment reflect the collective experience, expertise, and focused effort of these biologists and hydrologists from USACE, USGS, NRCS, and WDNR. The results also reflect the guidance, input, review comments, and concurrence of the multi-organization Agency Technical Review of experts from USACE, USGS, NRCS, USFWS, and GLFC.

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 Great Lakes Fishery Commission (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 team comprised of 16 senior level experts from the USACE and these external partner agencies, including NOAA and 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 to forms. This one percent threshold criterion 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 being able 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 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 that may enable ANS to transit across the aquatic pathway or across the basin divide. Although these other pathways do not influence the overall pathway rating outlined in this report, they are included to point out potential other pathways (e.g., anthropogenic) and their potential influence on the same list of ANS as evaluated in Section 4 of this report. Any further analysis of these non-aquatic pathways outside of this study should develop a separate list of ANS that will likely differ from the list of ANS evaluated as part of this aquatic pathway 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 NAS as "…a species that enters a body of water or aquatic ecosystem outside of its historic or native range." (USGS, 2012). Based on discussions between the USACE, USGS, and USFWS the following definitions were established for the purposes of the GLMRIS. All non-indigenous 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 non-indigenous 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 non-indigenous aquatic species in this report.

2.3.1 Lists of Nonindigenous Species 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 non-indigenous 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 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.

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 pseudoharengus*	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 and 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 and trailers
fish	*Gymnocephalus 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 and trailers
bryozoan	*Lophopodella carteri*	bryozoans	GL	with aquatic plants
fish	*Menidia beryllina*	inland silverside	MS	swimmer
plant	*Murdannia keisak*	marsh dewflower	MS	recreational boating and trailers
fish	*Mylopharyngodon piceus*	black carp	MS	swimmer
crustacean	*Neoergasilus japonicus*	a parasitic copepod	GL	parasite to fish
plant	*Oxycaryum cubense*	Cuban bulrush	MS	recreational boating and 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 and trailers
mollusk	*Valvata piscinalis*	European stream valvata	GL	ships

2.3.3 List of ANS of Specific Concern at the Portage Upstream Location

The Portage Upstream aquatic pathway team then subdivided the set of species listed in Table 1 into two groups: ANS threatening the Great Lakes, and ANS threatening the Mississippi River and its tributaries. Each of these two lists was then sorted into subgroups in accordance with taxonomy and common dispersal mechanism. Table 2 and Table 3 reflect these groupings of species that were found to pose a significant risk to the Mississippi River and its tributaries, and to the Great Lakes and its tributaries, respectively (USACE, 2011b).

Additionally, the Portage Upstream aquatic pathway team reviewed the information on the 119 species initially determined to pose a potential threat of infiltrating the other basin to see if any were in close enough proximity to the Portage Upstream location to be of concern. The team reviewed information on the NOAA Watchlist of species threatening the Great Lakes from international waters, and information on other species cited by the review team as high risk potential invaders not yet in either basin (NOAA, 2011). No additional species from the NOAA Watchlist were added to the species of concern for the Portage Upstream location. However, the NOAA Watchlist was utilized as a resource, at the recommendation of agency team members, to identify any additional potential future species that could be introduced into either basin and possibly spread from there to the other basin.

There have been two known occurrences of ANS within a 25 mile (40 km) radius of the Portage Upstream location (Figure 2). These were two separate collections of bighead carp below the Prairie du Sac Dam on the Wisconsin River, about 25 miles (40 km) downstream from Portage. The nearest occurrence of ANS from the Great Lakes Basin side of the divide is that of viral hemorrhagic septicemia virus (VHSv) in the Lake Winnebago system about 50 miles (80.5 km) northeast of Portage.

Each Focus Area 2 aquatic pathway team was granted flexibility in determining whether to add additional species to their assessment based on their review of available information and the actual location of the specific potential pathway relative to the known location of those ANS being considered. Based on concerns from local agencies about the potential for spread of VHSv, each Focus Area 2 aquatic pathway team evaluated whether VHSv should be included on the ANS of concern list for each of the Focus Area 2 aquatic pathways. Although VHSv has been identified in both basins (i.e., VHSv was confirmed in the Clark Fork Reservoir, Ohio, in the Ohio River Basin), it is yet to be determined that VHSv has established in the Mississippi River Basin. Minimizing the spread of VHSv remains a priority for the state of Wisconsin (Great Lakes Commission, 2011; USGS, 2011b). VHSv is known to occur in the Lake Winnebago system, which is in the Great Lakes Basin (Kipp and Ricciardi, 2010). As a result, it was determined that VHSv would be considered a concern for passage over this divide location into the Mississippi River Basin.

Each of the three subgroups in Tables 2 and Table 3 were evaluated based on the dispersal mechanisms and general mobility of the species within each group. The Portage site is located at the headwaters of a drainage basin on the Great Lakes Basin side of the divide. However, it is located along a major river on the Mississippi River Basin side. This results in the opportunity for ANS to be transported over this divide location by floodwaters of the Wisconsin River from the Mississippi River Basin to the Great Lakes Basin. Even species without self-propelled mobility, such as plants and invertebrates, can be transported from the Mississippi River Basin to the Great Lakes Basin. However, species that occur on the Great Lakes Basin side of the divide must possess either self-propelled mobility or the ability to “hitchhike” on other organisms to travel upstream and over the divide into the Mississippi River Basin. This eliminates organisms on the Great Lakes Basin side that rely on current for dispersal such as plants, and most invertebrates. The parasitic copepod (*Neoergasilus japonicas*) was removed from consideration at this site because it is not yet reported from Lake Michigan or Lake Superior and the likelihood of it arriving at this pathway location seems too low.

Table 2: ANS of Concern Threatening the Mississippi River Basin.			
Taxon	**Scientific Name**	**Common Name**	**Interbasin Dispersal Mechanism**
fish	*Alosa aestivalis*	blueback herring	swimmer
fish	*Alosa pseudoharengus*	Alewife	swimmer
fish	*Gasterosteus aculeatus*	threespine stickleback	swimmer
fish	*Gymnocephalus cernua*	ruffe	swimmer
fish	*Petromyzon marinus*	sea lamprey	swimmer
fish	*Proterorhinus semilunaris*	tubenose goby	swimmer
crustacean	*Neoergasilus japonicus*	a parasitic copepod	parasite to fish
crustacean	*Bythotrephes longimanus*	spiny waterflea	ballast water/sediment
crustacean	*Cercopagis pengoi*	fish-hook water flea	ballast / rec. boating
crustacean	*Daphnia galeata galeata*	water flea	ballast water
crustacean	*Echinogammarus ischnus*	a European amphipod	ballast water
crustacean	*Hemimysis anomala*	bloody red shrimp	ballast water
crustacean	*Schizopera borutzkyi*	parasitic copepod	ballast water
mollusk	*Pisidium amnicum*	greater European pea clam	ballast water
mollusk	*Valvata piscinalis*	European stream valvata	ships
mollusk	*Sphaerium corneum*	European fingernail clam	ballast water
protozoan	*Psammonobiotus communis*	testate amoeba	ballast water
protozoan	*Psammonobiotus dziwnowi*	testate amoeba	ballast water
protozoan	*Psammonobiotus linearis*	testate amoeba	ballast water
annelid	*Branchuris sowerbyi*	tubificid worm	sediment transport
plant	*Carex acutiformis*	swamp sedge	recreational boats and trailers
plant	*Glyceria maxima*	reed sweetgrass	recreational boats and trailers
plant	*Trapa natans*	water chestnut	recreational boats and trailers
bryozoan	*Lophopodella carteri*	bryozoans	with aquatic plants
algae	*Bangia atropupurea*	red macro-algae	ballast / rec. boating
algae	*Cyclotella cryptica*	cryptic algae	unknown / any water
algae	*Cyclotella pseudostelligera*	cylindrical algae	unknown / any water
algae	*Enteromorpha flexuosa*	grass kelp	ballast / rec. boating
algae	*Stephanodiscus binderanus*	diatom	ballast water

Table 3: ANS of Concern Threatening the Great Lakes.			
Taxon	**Scientific Name**	**Common Name**	**Interbasin Dispersal Mechanism**
fish	*Alosa chrysochloris*	skipjack herring	swimmer
fish	*Channa argus*	northern snakehead	swimmer
fish	*Hypophthalmichthys molitrix*	silver carp	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	swimmer
fish	*Menidia beryllina*	inland silverside	swimmer
fish	*Mylopharyngodon piceus*	black carp	swimmer
crustacean	*Apocorophium lacustre*	a scud	ballast water
plant	*Landoltia (Spirodela) punctata*	dotted duckweed	recreational boats and trailers
plant	*Murdannia keisak*	marsh dewflower	recreational boats and trailers
plant	*Oxycaryum cubense*	Cuban bulrush	recreational boats and trailers

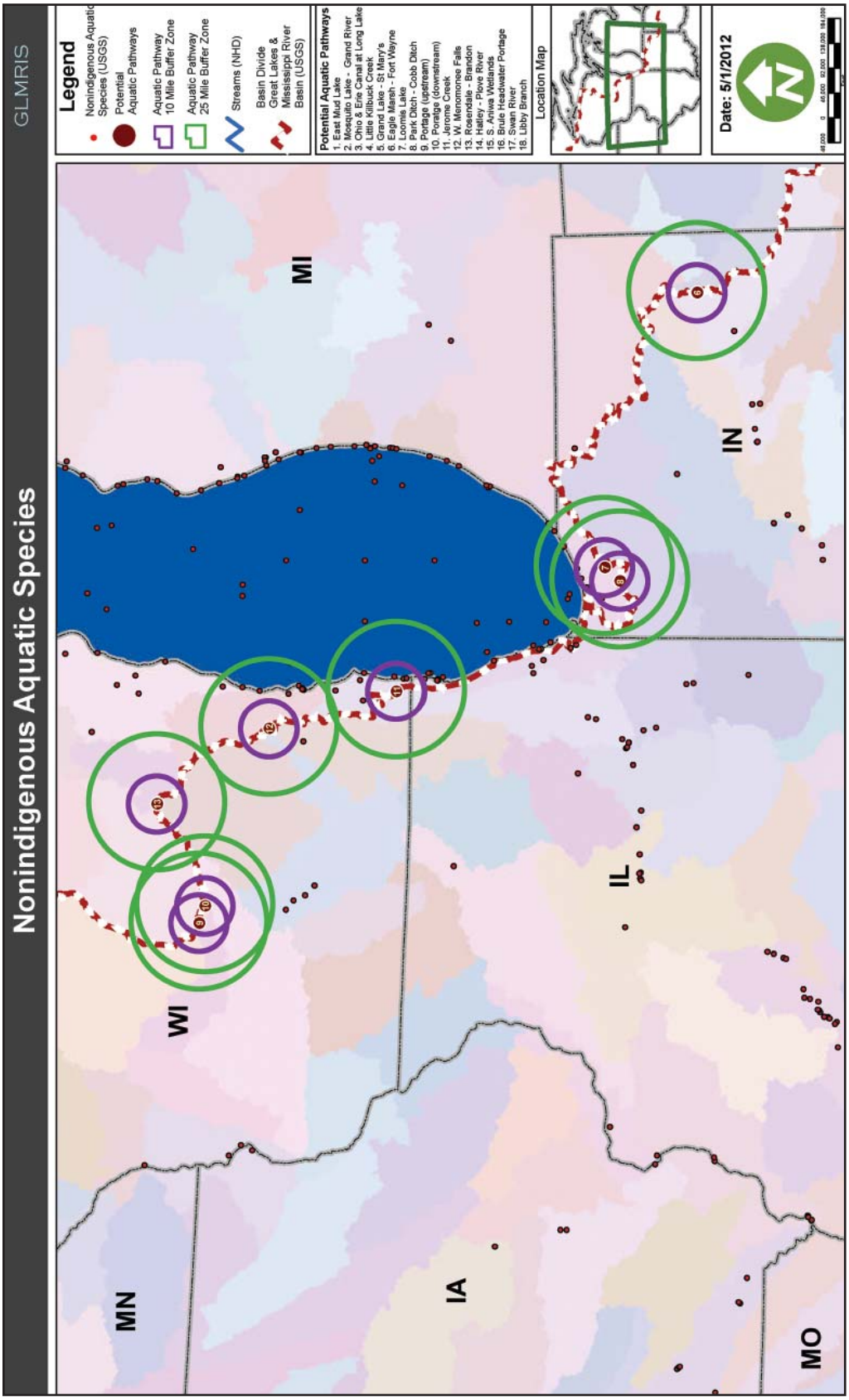

Figure 2. Map of ANS occurrences at Portage Upstream (site no. 9), as well as other nearby GLMRIS Focus Area 2 locations (USGS, 2011). Background imagery courtesy of Bing Maps.

No fishing or boating is occurs directly within the wetlands in the divide location, which eliminates the threat of ANS transfer via water craft, associated equipment or fishing gear. Dumping of ANS (discarded aquarium pets, religious ceremonies, etc.) within these wetlands is considered possible but unlikely because there would be more easily accessed and suitable habitat for such releases. Additionally, dumping of exotic pets is just as likely to occur in either basin or elsewhere along the basin divide. Organisms that possess the ability to hitchhike over land and therefore would be able to bypass an obstacle in the aquatic pathway were not included in the final list or evaluated in this report. State hatcheries only use brood stock determined to be VHSv free and collected from non-VHSv waters (W. Wawrzyn – WDNR, personal communication, March 2, 2012). Commercial fish hatcheries also are regulated under Wisconsin Administrative Code 10.61, and live bait dealers are regulated. The Wisconsin rules prohibit the harvest of wild minnows, both commercially and for personal use, from all VHSv known and suspect waters (WDNR, 2012a). It is illegal to possess or use minnow harvesting gear on any of the VHSv waters. In addition, the intestinal tract of warm-blooded animals inactivates the VHSv and the virus is not known to replicate in aquatic insects. Therefore, mammals, waterfowl, insects, and parasites are unlikely vectors for the spread of VHSv (Pennsylvania Sea Grant Fact Sheet, not dated).

Based on the evaluation by subgroups, only fish and parasites of fish were considered to have the requisite means of reaching the divide location from the Great Lakes Basin. Additionally, plants and an invertebrate were considered a risk for transfer by floodwaters from the Mississippi River Basin to the Great Lakes Basin. In total, eight fish, three plants, a crustacean, and one virus were identified as species of concern for the Portage Upstream site (Table 4). These were chosen based on their relative proximity to the site, history of invasiveness, and physical capabilities to utilize this aquatic pathway within the next 20 years.

2.3.4 Key Attributes of Selected Organisms

Excluding the information for VHSv, a significant amount of ANS information was obtained from the USACE White Paper listing the non-native species of concern and dispersal risk for GLMRIS (USACE, 2011b). The VHSv was not identified as a species of concern in this white paper. However, during interagency coordination VHSv was identified as a species of concern for Portage Upstream. Additional information was obtained from the USGS Nonindigenous Aquatic Species (NAS) website (USGS, 2011).

Table 4: Species of Greatest Concern for Transfer at Portage Upstream.

Taxon	Scientific Name	Common Name	Basin	Interbasin Dispersal Mechanism
fish	*Hypophthalmichthys molitrix*	silver carp	MS	swimmer
fish	*Hypophthalmichthys nobilis*	bighead carp	MS	swimmer
fish	*Mylopharyngodon piceus*	black carp	MS	swimmer
fish	*Menidia beryllina*	inland silverside	MS	swimmer
fish	*Channa argus*	northern snakehead	MS	swimmer
fish	*Gasterosteus aculeatus*	threespine stickleback	GL	swimmer
fish	*Gymnocephalus cernua*	ruffe	GL	swimmer
fish	*Proterorhinus semilunaris*	tubenose goby	GL	swimmer
virus	*Viral Hemorrhagic Septicemia virus*	VHSv	GL	pathogen to fish/water column
crustacean	*Apocorophium lacustre*	a scud	MS	ballast water
plant	*Landdoltia (Spirodela) punctata*	dotted duckweed	MS	recreational boats and trailers
plant	*Murdannia keisak*	marsh dewflower	MS	recreational boats and trailers
plant	*Oxycaryum cubense*	Cuban bulrush	MS	recreational boats and trailers

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 given the large number of potential pathways, 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:

$P_1 = P_{ANS\ associated\ with\ pathway}$
$P_2 = P_{ANS\ survives\ transit}$
$P_3 = P_{ANS\ colonizes\ in\ new\ environment}$
$P_4 = P_{ANS\ spreads\ beyond\ colonized\ area}$

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, Reasonably Certain, Moderately Certain, Reasonably Uncertain, Very Uncertain). 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:

$P_0 = P_{Pathway\ exists}$
$P_1 = P_{ANS\ has\ access\ to\ pathway}$
$P_2 = P_{ANS\ transits\ pathway}$
$P_3 = P_{ANS\ colonizes\ in\ new\ waterway}$
$P_4 = P_{ANS\ spreads\ in\ new\ waterway}$

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_3) and spread (P_4) 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 *ANS transits pathway*

P_{2a} = P *ANS surviving transit to aquatic pathway*

P_{2b} = P *ANS establishing at the aquatic pathway*

P_{2c} = P *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 at 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" 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 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 up to a one percent annual recurrence interval event) was estimated to be low, 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 where the probability of a pathway existing (P_0) was determined to be medium or high which includes the Portage Downstream pathway, the remaining four elements in Equation 5 were evaluated for each ANS of concern specific to that particular location over a 50 year period of analysis..

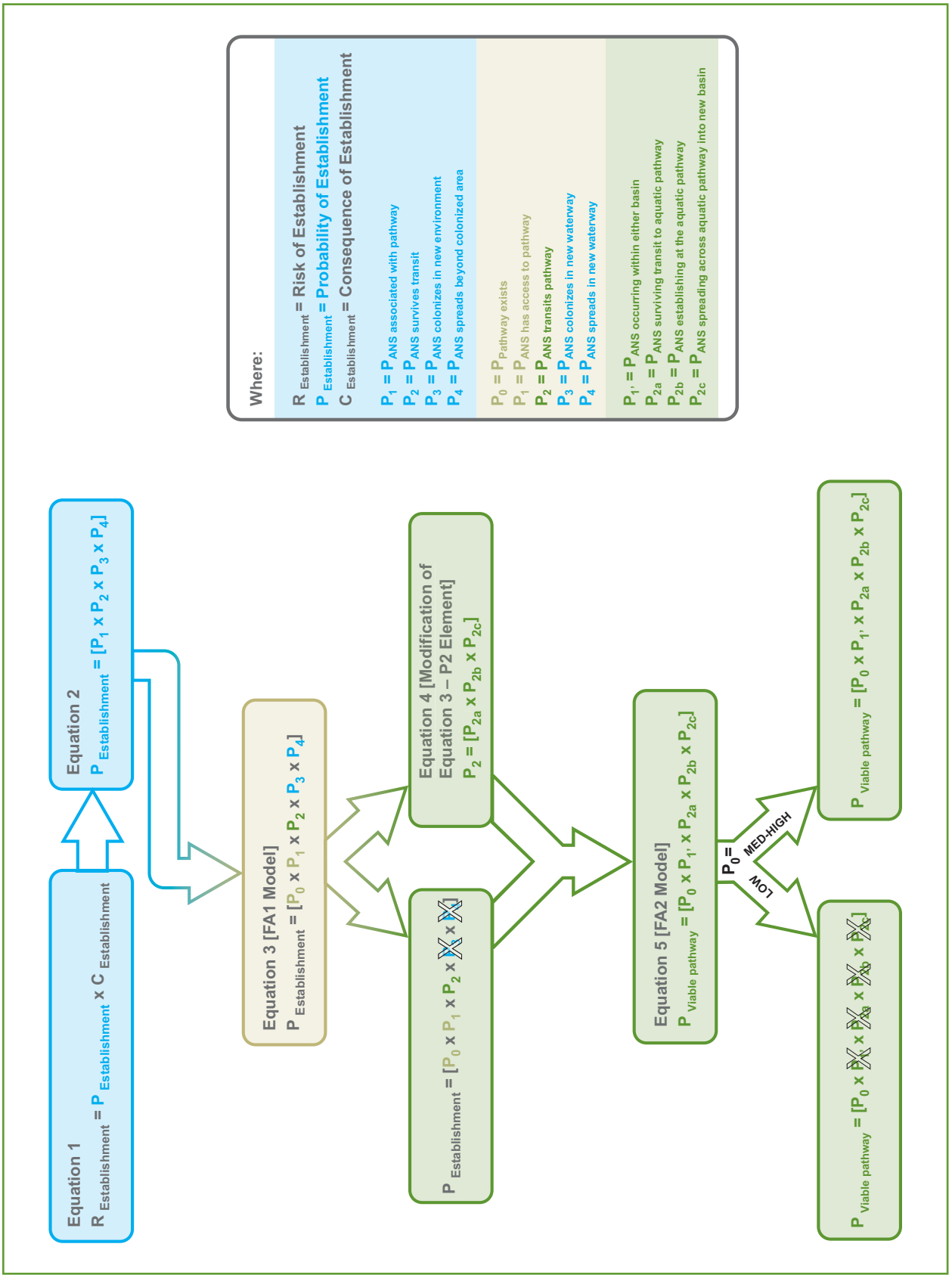

Figure 3. Diagram of the derivation of the GLMRIS Focus Area 2 aquatic pathway assessment model.

2.5 Example Calculation of Overall Aquatic Pathway Viability

As described in Section 2.2, a list of ANS of concern for the Portage Upstream pathway was developed with input from Federal, State, and local agencies responsible for water resources, and fish and wildlife management in the state of Wisconsin and neighboring states along the Great Lakes and Mississippi River Basin divide. ANS of concern were grouped according to which basin they were currently established in to determine the viability of the aquatic pathway to transfer species across the divide in either direction. The determination of the likelihood of a viable aquatic pathway for each ANS of concern is the product of five probability elements (Equation 5). Thus, the probability of a viable pathway for a particular ANS of concern is equal to the lowest rating determined for each of the five probability elements (Table 5 and Table 6). The overall pathway viability for transferring ANS of concern from the Mississippi River Basin to the Great Lakes Basin was equal to the highest probability of a viable pathway for each ANS of concern in Table 4. In this example, all were rated low and thus the overall pathway viability for transferring species from the Mississippi River Basin to the Great Lakes Basin is "low". The overall pathway viability for transferring species from the Great Lakes Basin is calculated the

Table 5. Example calculation of Pathway Viability for ANS Spreading from Mississippi River Basin to the Great Lakes Basin.

			Form 1 P_0	Form 2 P_1	Form 3 P_{2a}	Form 4 P_{2b}	Form 5 P_{2c}	$P_{viable\ pathway}$
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists?**	**ANS Occuring Within Either Basin?**	**ANS Surviving Transit to Pathway?**	**ANS Establishing at Aquatic Pathway?**	**ANS Spreading Across Aquatic Pathway into New Basin?**	**ANS/Pathway Viability Rating**
fish	Asian carp, silver carp, bighead carp, black carp	swimmer	M (RC)	M (RC)	L (RC)	L (MC)	M (RU)	L
fish	inland silverside	swimmer		M (VC)	L (MC)	L (RC)	L (RC)	L
Overall Pathway Viability for Spread of ANS from Mississippi River Basin to Great Lakes Basin								**L**

VC=Very Certain (as certain as going to get), RC=Reasonably Certain (reasonably certain), MC=Moderately Certain (more certain than not), RU=Relatively Uncertain (reasonably uncertain), VU=Very Uncertain (a guess)

Table 6. Example calculation of Pathway Viability for ANS Spreading from Great Lakes Basin to the Mississippi River Basin.

			Form 1 P_0	Form 2 P_1	Form 3 P_{2a}	Form 4 P_{2b}	Form 5 P_{2c}	$P_{viable\ pathway}$
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists?**	**ANS Occuring Within Either Basin?**	**ANS Surviving Transit to Pathway?**	**ANS Establishing at Aquatic Pathway?**	**ANS Spreading Across Aquatic Pathway into New Basin?**	**ANS/Pathway Viability Rating**
fish	threespine stickleback	swimmer	M (RC)	M (VC)	L (RC)	L (MC)	L (MC)	L
pathogen	VHSv	fish pathogen / water column		H (VC)	H (MC)	H (RC)	H (RU)	M
Overall Pathway Viability for Spread of ANS from Great Lakes Basin to Mississippi River Basin								**M**

same way and is shown in Table 5. In this example, the overall pathway viability for transferring species from the Great Lakes Basin to the Mississippi River Basin is “medium”.

The last calculation is to determine the overall pathway viability for interbasin spread of ANS which is calculated by taking the highest of the overall ANS ratings for unidirectional transfer which were calculated in Tables 5 and 6. Thus, in Table 6, the overall probability that a viable aquatic pathway exists is “medium”. The ratings given for each element as well as the overall pathway viability ratings shown in Tables 5 and 6 were coordinated amongst the members of the pathway team until agreement was reached regarding the probability rating (H, M, or L) and the level of certainty (VC, RC, MC, RU, or VU).

3 Aquatic Pathway Characterization

This section describes and illustrates the topography and features in the vicinity of the potential pathway and is intended to help inform the biological evaluations contained in Section 4 of this report with a compilation of any readily available and applicable information of this area as it may influence local hydrology. Maps, photographs, and figures are included to aid understanding of the significant hydrologic and hydraulic conditions near the drainage divide. Also, this section identifies any significant data gaps and uncertainties related to the available topographic information and hydrologic modeling in the area of interest.

3.1 Location

The Portage Upstream potential pathway is located upstream, or west of Portage, Wisconsin in Columbia County. An image of the Portage area with the Portage Upstream and Portage Canal potential connections labeled, is shown in Figure 4. The Portage Upstream area consists of three discrete locations where interbasin flow can occur. The Portage Canal locations are also shown for reference. However, Portage Downstream, and Canal are addressed in a separate aquatic pathway assessment report. The Fox River drains to the Great Lakes Basin and the Wisconsin River drains to the Mississippi Basin. The Portage area has historically been an area with high potential for interbasin exchange of water. Early settlers recognized this and actually established a navigable waterway and lock and dam system between the Fox and Wisconsin Rivers.

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. Existing information about climate and future climate change (if available) are important considerations for predicting the frequency of interbasin flows. Based on streamflow gage data throughout the Upper Midwest, average annual flows and the number of peak flows is increasing. However, on the Wisconsin River, operation of upstream reservoirs may be masking changes in annual flows at Portage.

Climate is an important driver to precipitation, temperature, snow melt, and flooding. This area of south-central Wisconsin is classified as continental with large seasonal temperature variance, four distinct seasons and relatively small or moderate precipitation. Temperatures in winter typically range from 12º F to 30º F (-11º C to -1º C), while summers are usually around 65º F to 75ºF (18º C to 24º C) (Table 7). Normal annual precipitation is about 35 inches (89 cm) and the normal snowfall is around 39 inches (99 cm). Significant snowfall and accumulation of snow usually occurs during the months of December through March. Warmer temperatures in April and May produce snowmelt runoff which when combined with increasing rainfall usually results in the peak flow rates for the year. However, significant rainfall events can occur throughout the summer and fall producing high flow rates. For instance, the flood of record at Portage occurred in September of 2010.

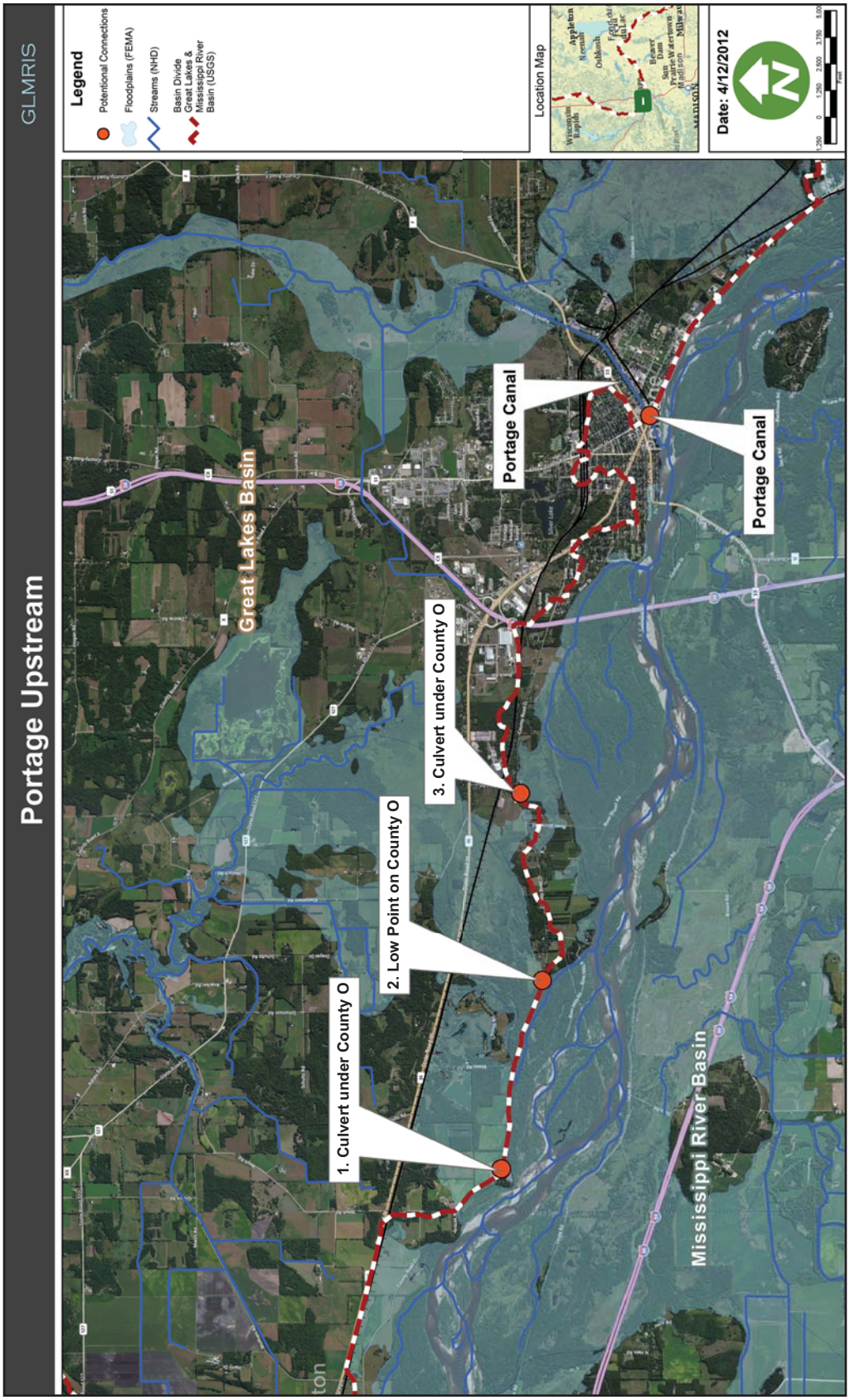

Figure 4. Portage Wisconsin location map. Red/White line is basin divide. The three Portage Upstream potential connections are labeled and Portage Canal is indicated for reference. Background imagery courtesy of Bing Maps.

Table 7: Climate Information for Portage, WI (National Climate Data Center, 1971-2000) (Midwestern Regional Clmate Center – Station Portage, WI).

Element	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
Mean Temperature°F	15.2	20.6	32.0	45.2	57.1	66.6	70.6	68.2	59.3	48.1	34.3	21.5	44.9
Mean Temperature °C	-9.3	-6.3	0.0	7.3	13.9	19.2	21.4	20.1	15.2	8.9	1.3	-5.8	7.2
Normal Precip (in)	1.26	1.22	2.25	3.50	3.55	4.17	4.45	4.33	3.54	2.40	2.45	1.41	34.53
Normal Precip (cm)	3.2	3.1	5.7	8.9	9.0	10.6	11.3	11.0	9.0	6.1	6.2	3.6	87.7
Mean Snow (in)	11.4	7.5	5.8	2.1	0.0	0.0	0.0	0.0	0.0	0.3	3.4	8.4	38.9
Mean Snow (cm)	29.0	19.1	14.7	5.3	0.0	0.0	0.0	0.0	0.0	0.8	8.6	21.4	98.8

The highest precipitation accumulation occurs in the summer months during June through August. Although rainfall amount do not always conform to averages, they are suggestive that substantial precipitation does not occur frequently and a greater than average amount of precipitation would likely be necessary to cause a surface water connection to form between the basins, although this is an area of uncertainty due to a lack of data linking precipitation amounts to the behavior of surface hydrology at the pathway location. Note also that the average temperatures at this location during a portion of the year are below freezing and represent times during which interbasin flow is less likely to occur because of reduced flows.

3.3 Location Specific Surface Water Features

Surface water features, as illustrated on Figures 5 and 6, are the most likely aquatic conduits for the transfer of ANS between basins. Some of the key features of the Portage Upstream Pathway as well as the three specific locations where interbasin flows may potentially occur are shown in Figure 6. The probability of an aquatic pathway existing at Portage Upstream is based off an evaluation of all three of these locations. The inverts of the culverts for connections 1 and 3 are not known. However, they are most likely lower than the crest of the lowest point along the Lewiston Levee at connection 2. This means that a pathway potentially exists by flood water through the culverts sooner than when the levee is overtopped. The upstream culvert at connection 1 is gated, however, it is not known if the downstream culvert has a gate on it since it was inaccessible during the site inspection.

The construction of the Lewiston Levee and County Road O (which are essentially parallel to each other), the Soo Line Railroad tracks, Highway 16, and other roadways are all likely to have altered the frequency and magnitude of natural interbasin exchanges. For existing conditions, the Federal Emergency Management Agency (FEMA) one percent annual recurrence interval base flood elevation (BFE) across the Portage Upstream pathway is elevation 781 feet (238 m) on the Fox River at the mouth of Neenah Creek, while the BFE on the Wisconsin River is elevation 801 feet (244 m), which is 20 feet (6.1 m) higher. The bed of the Wisconsin River varies from 780 to 790 feet (238-241 m) in the Lewiston Levee Reach meaning that most of the Wisconsin River bed is higher than the one percent BFE on the Fox River. For this reason, the hydrologic exchange (i.e. gravity flow) is likely from the Wisconsin River to the Fox River in all cases.

The flooded area outline for the one percent annual recurrence interval flood, based on the Columbia County Flood Insurance Study (FIS), is shown in Figure 7. The flooded area outline extends across the basin divide and indicates that the entire Portage Upstream pathway would be inundated. Therefore, water from the Wisconsin River would flow across the divide and into tributaries of Big Slough, which flows

into Neenah Creek and then to the Fox River. Further discussion of the Columbia County FIS, including the frequency and duration of flooding at the basin divide and flows in the tributaries for various flood events, is discussed in Section 3.5: Aquatic Pathway Temporal Characteristics.

Representative geometry for the three specific locations where interbasin flows potentially occur, based on the best available geographic information system (GIS) elevation data, is shown in Figures 8-10. Included in Figures 8-10 are profiles along with the Hydrologic Unit Code (HUC) boundary and a representative cross section across the HUC boundaries. The cross section provides information for ground elevations from one side of the divide to the other. At locations 1 and 3, the culvert invert elevations are lower than the surface elevations depicted in Figures 8 and 10. At location 1 the culvert is gated, and even if it is not opened the difference in the elevation of the road and Lewiston Levee is only approximately 10 feet (3 m) higher than the channel elevation for the Wisconsin River. At location 3 the difference in elevation between the existing channel of the Wisconsin River and the top of the Lewiston Levee is approximately 5 feet (1.5 m). The vertical elevation difference across the divide at Location 2 appears to be less than 5 feet (1.5 m). For this pathway, the elevations are based on the USGS 10-meter Digital Elevation Model (DEM) with a vertical accuracy of +/- 13.123 feet (4 m). This level of accuracy may lead one to conclude that there is a high degree of uncertainty regarding the potential for watershed connections being established during flood events. However, the absolute vertical accuracy (specific elevation) is not nearly as important as the relative, or point-to-point, vertical accuracy (terrain) when evaluating terrain at the divide location to try and predict hydrology. Point-to-point accuracy has been shown to be much greater than this margin of error regarding absolute elevation would indicate.

Although the absolute elevation values may vary from the true value (i.e., 800 feet (244 m) above sea level), they tend to vary a comparable amount at adjacent points so that the terrain of the area is depicted relatively well. The grid size used to create the DEM can also affect the accuracy of the DEM. The larger the grid cell size (10 m vs. 30 m), the less detailed the terrain appears and thus the less accurately the DEM depicts the actual terrain. The largest grid size used at any of the pathway locations is 10 m, with some areas having more detailed information. Even though the 10 m cell size does not depict every hummock or hollow in the terrain, it does provide sufficient detail regarding general terrain and relative elevations to provide useful data in evaluating the potential for a hydrologic connection forming across the basin divide. Thus, it appears that a flood event that would result in raising the stage in the Wisconsin River approximately 5-10 feet (1.5-3 m) would result in flows across the basin divide.

3.4 Groundwater

Surface water features (e.g. ditches and ponds) may at times be fed by groundwater, and during low flow periods groundwater may even be the primary sources of water for these features.

Portage Upstream Subsurface Flow

As mentioned previously for existing conditions, the one percent annual recurrence interval BFE across the Portage Upstream pathway is elevation 781feet (238 m) on the Fox River end (at the mouth of Neenah Creek) while the BFE on the Wisconsin River end of the pathway is elevation 801 feet (244 m), which is 20 feet (6.1 m) higher. The bed of the Wisconsin River varies from 780 to 790 feet (238-241 m) in the Lewiston Levee Reach while the bed of the Fox River varies from 766 to 768 feet (233-234 m) near the confluence with Neenah Creek. Since the river bed and the one percent BFE are so much higher on the Wisconsin River it is believed that sub-surface water exchange is usually from the Wisconsin River to the Fox River. It is possible that local or interior drainage following a major flood event on both rivers could result in seepage back to the Wisconsin River. However, this would be limited to short periods of time. It should be noted that sub-surface water exchange includes seepage through levees, roadway embankments, or natural ground features along the pathway that may be caused due to rise and fall of water on either side of the pathway. This does not imply knowledge of movement within the deeper groundwater aquifer, which is discussed below.

Groundwater Aquifer

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 seasonally in response to 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. Net recharge to the aquifers also occurs in the fall of most years, due to rainfall and low evapotranspiration rates. The nearest available groundwater data, USGS Groundwater Watch site 433956089275601, is seven miles (11.2 km) north of the pathway site. A second gage, USGS Groundwater Watch site 432921089245901, is seven miles (11.2 km) southeast of the pathway site. These gages are both far enough from the area of interest that they cannot provide direct data about the potential pathway's groundwater conditions. Although no groundwater data in the immediate vicinity of the pathway is available, groundwater conditions are not believed to increase the likelihood of a surface water connection being maintained between these watersheds.

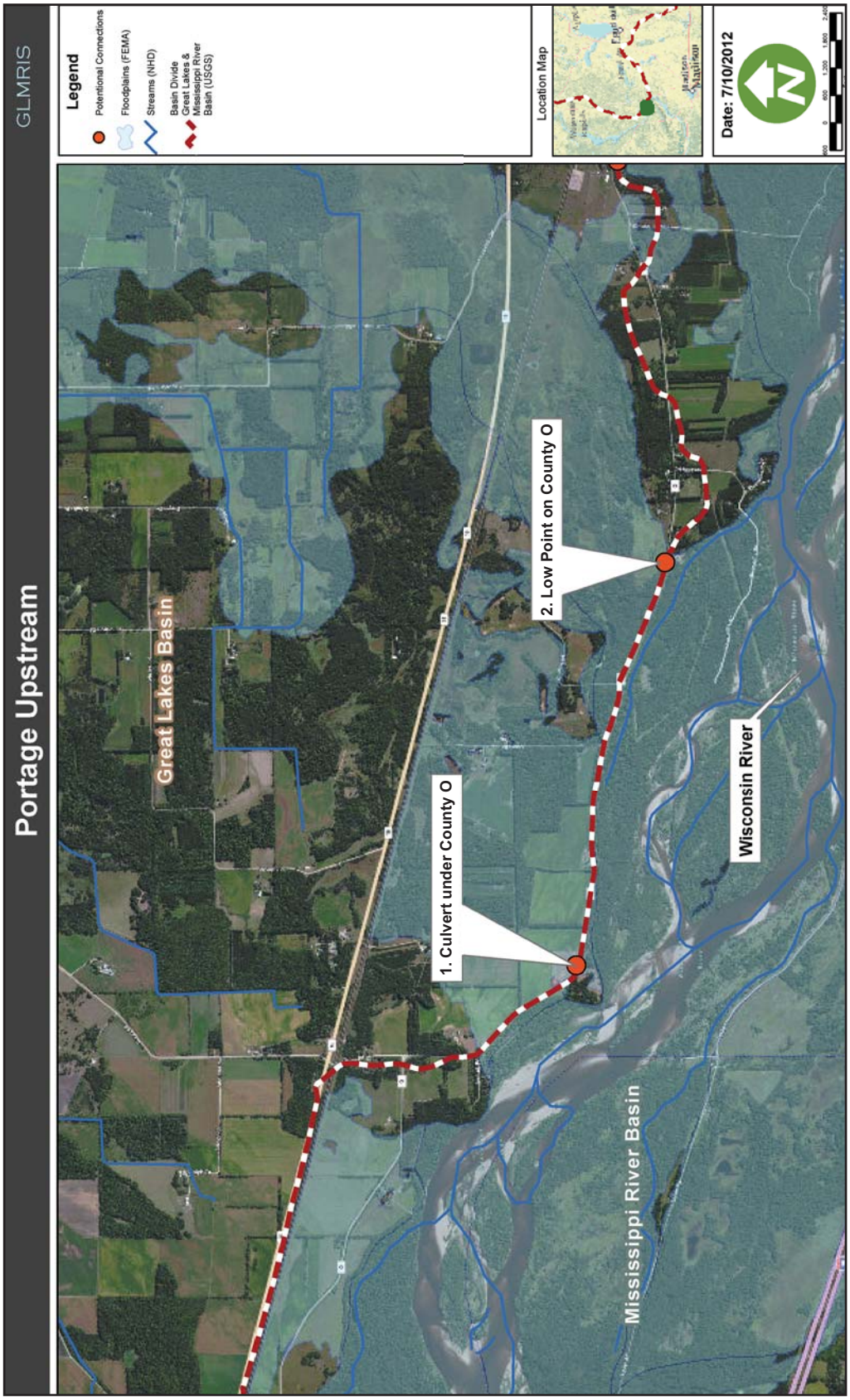

Figure 5. Locations 1 and 2 where interbasin flows potentially occur at the Portage Upstream pathway. Red/White line is basin divide. Background imagery courtesy of Bing Maps.

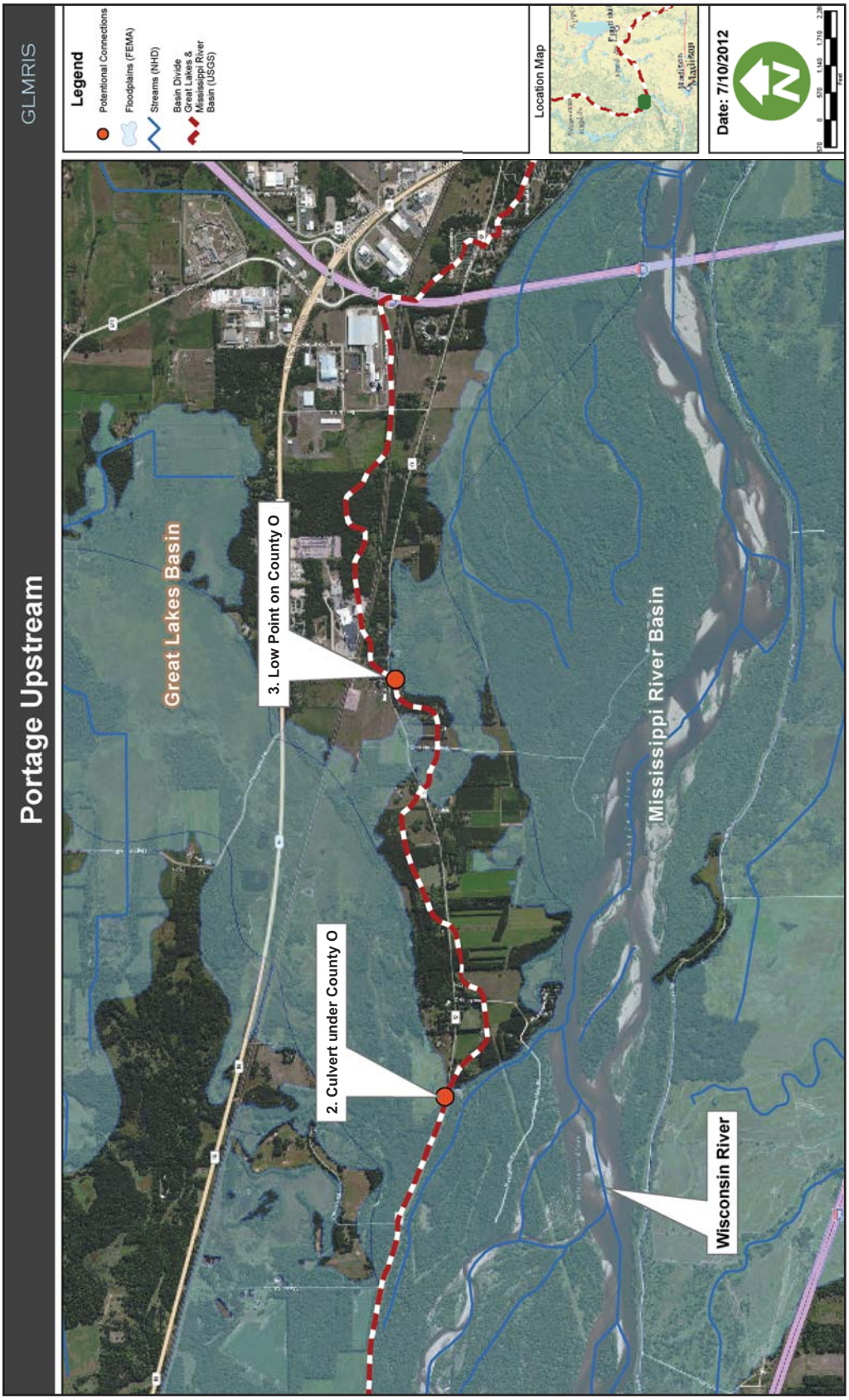

Figure 6. Locations 2 and 3 where interbasin flows potentially occur at the Portage Upstream pathway. Red/White line is basin divide. Background imagery courtesy of Bing Maps.

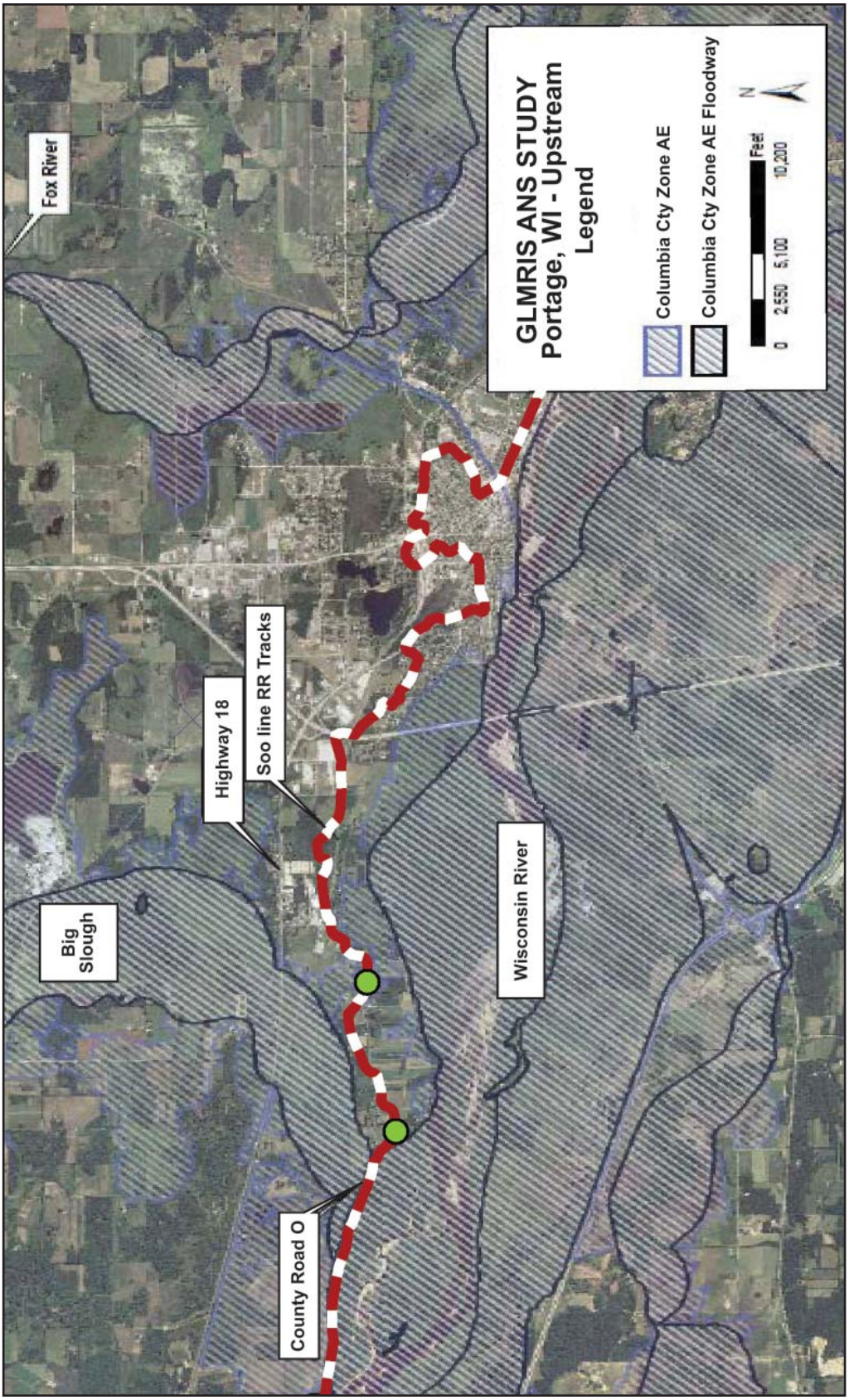

Figure 7. Flooded area outline for the 1 percent annual recurrence interval flood at the Portage Upstream Pathway. Shaded areas indicate FEMA 1 percent floodplain and green circles indicate pathway locations. Background imagery courtesy of Bing Maps.

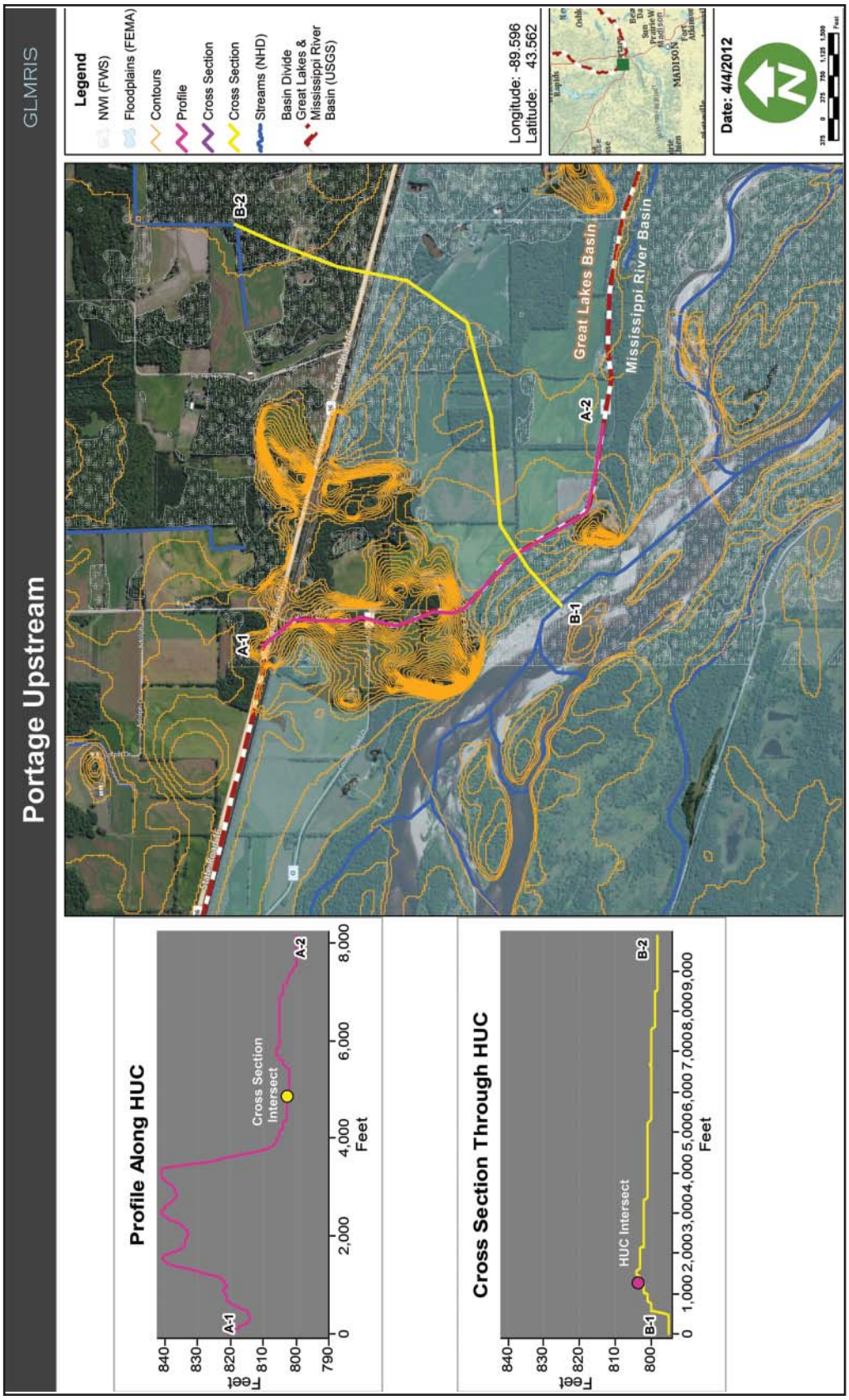

Figure 8. Typical cross-sections at Location 1, based on 10m DEM, with a vertical accuracy of +/-13ft. Red/white line is the basin divide. Pink line in the photograph and the graph on the top left is this cross section along the basin divide. The yellow line that intersects the pink line in the photograph and the graph on the bottom left is the cross section through the basin divide. Culvert at this location is gated and invert elevation of culvert is lower than surface elevations shown. Background imagery courtesy of Bing Maps.

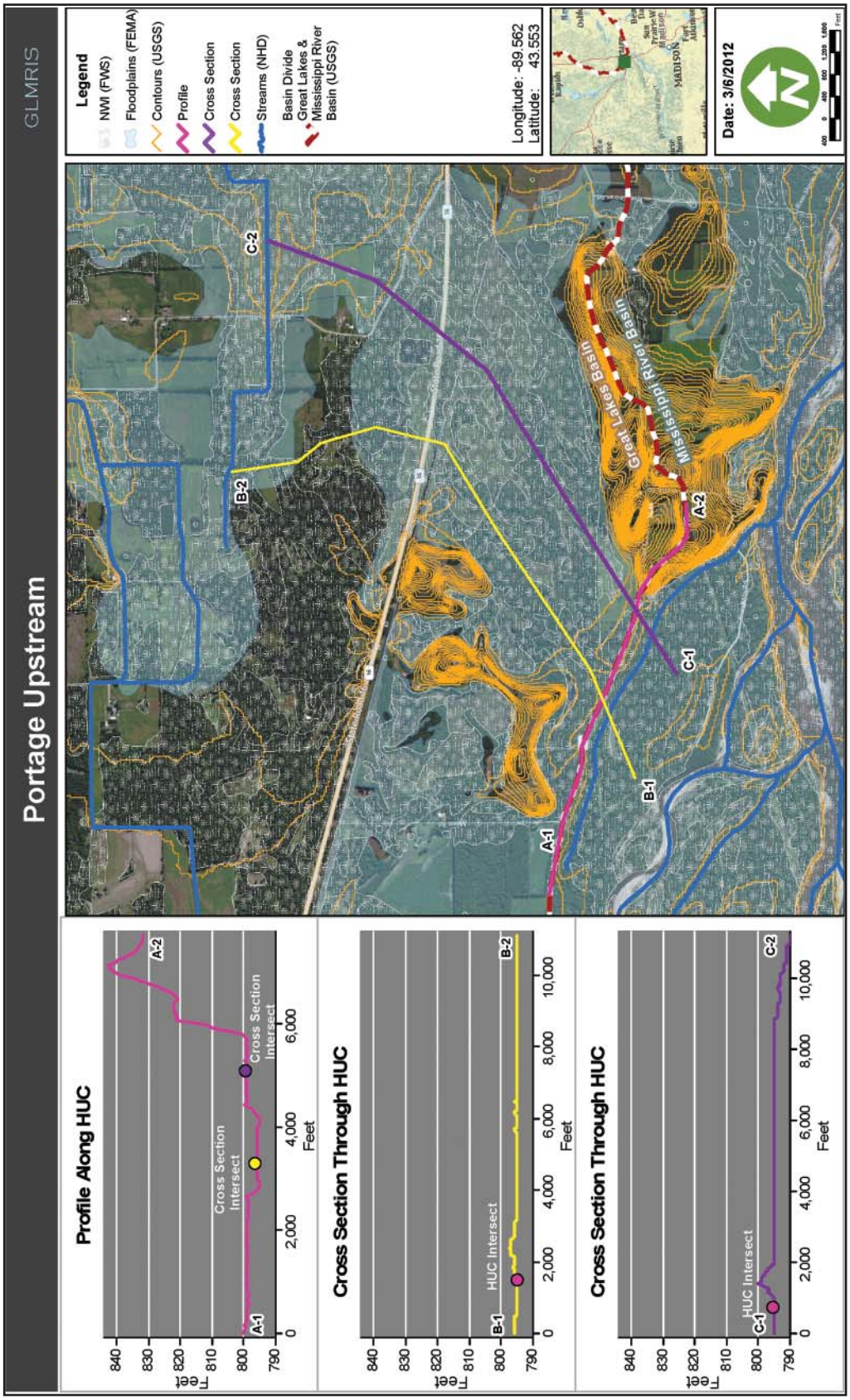

Figure 9. Typical cross-sections at Location 2, based on 10m DEM, with a vertical accuracy of +/-13 feet (4 m). Red/white line is the basin divide. Pink line in the photograph and the graph on the top left is this cross section along the basin divide. The yellow and purple lines that intersect the pink line in the photograph and the graphs on the middle and bottom left are the cross sections through the basin divide. Background imagery courtesy of Bing Maps.

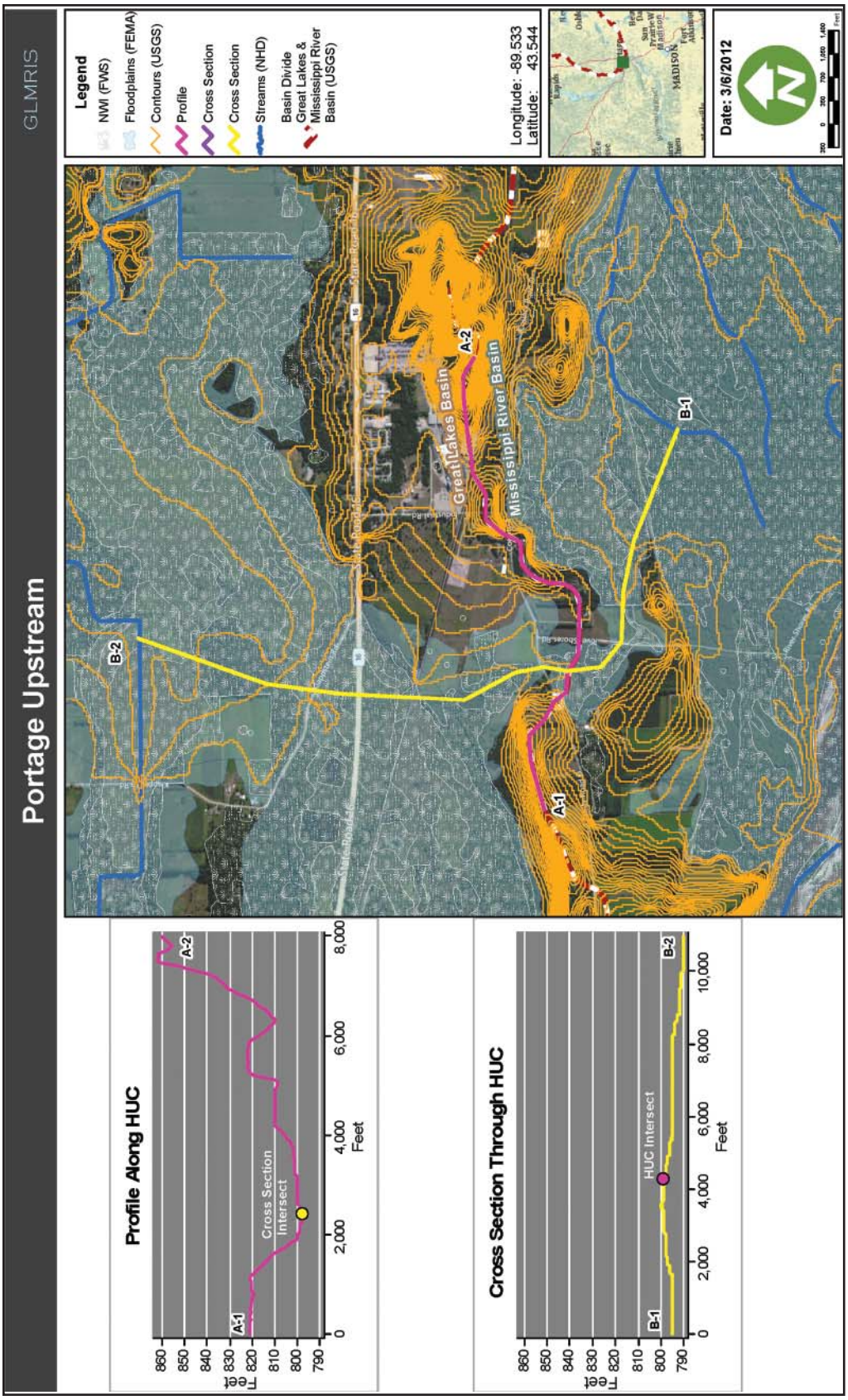

Figure 10. Typical cross-sections at Location 3, based on 10m DEM, with a vertical accuracy of +/-13feet (4 m). Red/white line is the basin divide. Pink line in the photograph and the graph on the top left is this cross section along the basin divide. The yellow line that intersects the pink line in the photograph and the graph on the bottom left is the cross section through the basin divide. Culvert at this location is gated and invert elevation of culvert is lower than surface elevations shown. Background imagery courtesy of Bing Maps.

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 dispersal and reproduction patterns and abilities to survive and establish populations in various areas. The Portage Upstream pathway has been identified by FEMA to be in the one percent recurrence interval flood zone (Figure 7), with determined base flood elevations. The FEMA's FIS of Columbia County, Wisconsin, which was completed in 2008, indicates that when flood events of similar frequency occur on both rivers, flow across the pathway will be from the Wisconsin River to the Fox River (Table 8). These flood events usually occur in the spring due to snowmelt and rainfall. However, flood conditions can also occur in the summer or fall. The FIS adopts the best estimate (or mean value) of the one percent annual recurrence interval flood elevation as the BFE in floodplain mapping. However, the actual one percent annual recurrence interval flood elevation may be higher or lower than the mean value depending on the standard deviation of modeling parameters. The mean monthly discharge from 2000 to 2010 on the Wisconsin River at Wisconsin Dells (USGS gage no. 05404000) just upstream of Portage, Wisconsin demonstrates the fact that the highest flows usually occur in spring, but high events can occur in summer and fall (Figure 11).

The magnitude of total interbasin flow at the Portage Upstream pathway is provided for concurrent flood events on the Wisconsin and Fox Rivers (Table 9). This information is based on hydrologic and hydraulic simulations done for the Columbia County (Portage) FIS, which was completed in 2008. Information is also given as to the condition of each of the three connection points identified in Figures 3 and 4. A "yes" is given for connection points 1 and 3 because of the possibility that these culverts could be left open and the inverts are probably lower than the 10 percent annual recurrence interval flood. However, the hydraulic modeling for the FIS assumed that the culvert was closed.

The depth of water along this pathway is highly variable, and increases with larger flood events. The water depths for the 10 percent annual recurrence interval event along the Portage Upstream pathway vary from less than one foot (30 cm) at County Road O to approximately ten feet (3 m) at the mouth of Neenah Creek at the Fox River. In Neenah Creek and Big Slough, open channel flow exists with water depths ranging from five (1.5 m) to ten feet (3 m) over the lower 78,000 feet (14.8 miles or 23.8 km). However, in the upstream areas closer to the actual interbasin connection, flow depths are shallower. The water surface profile and stream bed elevation, based on the Columbia County (Portage) FIS along the upper 39,000 feet (approximately seven miles or 12 km) of the 116,000 foot long (approximately 22 miles or 35 km) distance from the basin divide to the confluence of Neenah Creek with the Fox River, is shown in Figures 12 and 13. In the upper 13,000 feet (4 km), flow depths are one-half to two feet (15-61 cm) deep, with the shallowest depths of one-half foot (15 cm) occurring in the Lewiston Levee and County Road O overflow areas.

The maximum flow velocity between the basin divide and the confluence of Neenah Creek with the Fox River for the one percent annual recurrence interval event is 2.4 feet per second (0.73 meters per second) at County Highway O, but velocities are less than two feet per second (0.61 meters per second) in most locations. Specific information can be found by referring to the floodway tables and water surface profiles in the Columbia County FIS.

The 2010 flood was the record stage at Portage. It is only the eighth highest discharge based on the USGS gage at Wisconsin Dells which is the nearest continuous gage upstream of the project. Whether this means there has been a long-term upward shift in the rating curve or that this is simply an anomaly associated with the 2010 flood is not known. However this inconsistency of peak stage versus peak discharge relationship reduces the confidence in determining the threshold for the formation of an aquatic pathway, and may have to be investigated further in the future. The formation of an aquatic pathway is more likely to occur if the 2010 flood data is shown to indicate an upward shift in the rating curve.

The discharge at the Wisconsin Dells gage was 55,700 cfs (1,577 cms) in 2010, which is slightly larger than

Table 8. Elevation and Discharge Statistics for Big Slough and the Wisconsin River near the Portage Upstream Site. The discharges are based on the peak discharge-frequency relationships developed for the Columbia County FIS (FEMA 2008 FIS).

	10% Annual Recurrence interval	2% Annual Recurrence interval	1% Annual Recurrence interval	0.2% Annual Recurrence interval
Breakout flow to Big Slough at Lewiston Levee	0	2,900cfs (82 cms)	5,150 cfs (146 cms)	10,600 cfs (300 cms)
Wisconsin River downstream of Lewiston	54,000 cfs (1,529 cms)	70,104 cfs (1,985 cms)	76,856 cfs (2,176 cms)	96,238 cfs (2,725 cms)
Elevation of Wisconsin River along Lewiston Levee	797-800 feet (243-244 m)	799-802 feet (243.5-244.5 m)	799-803 feet (243.5-244.7 m)	800-803 feet (244-244.7 m)
Elevation of Fox River at mouth of Neenah Creek	777.3 feet (236.9 m)	778.5 feet (237.3 m)	781.1 feet (238.1 m)	784.5 feet (239.1 m)

Table 9. Magnitude of total interbasin flow at the Portage Upstream pathway and the status of individual sites for various concurrent flood events on the Wisconsin and Fox Rivers. The magnitude of river flow was obtained from HEC-2 and HEC-RAS split flow modeling for the Portage FRM Project and the Columbia County (Portage) FIS. Flows are given in cubic feet per second (cfs) and cubic meters per second (cms). The status of whether the three specific sites are conveying water is based on information from the Wisconsin Department of Natural Resources.

Flood Frequency	10% Annual Recurrence interval	2% Annual Recurrence interval	1% Annual Recurrence interval	0.2 % Annual Recurrence interval
Interbasin Flow (cfs/cms)	0	2,900 (82)	5,150 (145)	10,600 (300)
Port u/s 1 Connection	Yes	Yes	Yes	Yes
Port u/s 2 Connection	No	Yes	Yes	Yes
Port u/s 3 Connection	Yes	Yes	Yes	Yes

the 10 percent recurrence interval flood of 54,000 cfs (1,529 cms). Wisconsin DNR personnel confirmed that there was no flow over the Lewiston levee during the 2010 flood, but water levels were within one to two feet (30-61 cm) of the top of the levee (A. Morton and K. Margovsky- WDNR, personal communication, August 9, 2011). The observations from the WDNR match the hydraulic modeling that was done for Portage, which indicates that for the 10 percent annual recurrence interval flood there results in no discharge over the Lewiston Levee (Table 9). But the hydraulic modeling also shows that for a two percent annual recurrence interval flood, there is 2,900 cfs (82 cms) flowing over the Lewiston Levee. That amount of flow would create a hydraulic pathway between the Wisconsin and Fox Rivers. It should be noted that if the two culverts through the Lewiston Levee and County Road O are left open, then interbasin flow begins earlier (smaller flood event).

The analysis done for the Columbia County FIS to determine discharges from the Wisconsin River into Big Slough assumed two scenarios: The Lewiston levee holds and the Lewiston Levee fails. The floodway limits developed for the Columbia County FIS assume that the Lewiston Levee fails. The Lewiston Levee was not designed to standards associated with USACE flood risk management (FRM) projects, and is vulnerable to failure during flood events approaching the 10 percent annual recurrence interval flood. The important thing for the Portage Upstream pathway assessment is that even if the levees hold, they are still overtopped for an event just slightly greater than the 10 percent annual recurrence interval flood.

Information on the duration of flooding for each of the eight events that had mean daily flows exceeding the 10 percent annual recurrence interval flood of 54,000 cfs (1,529 cms) during the time period 1935 to 2011

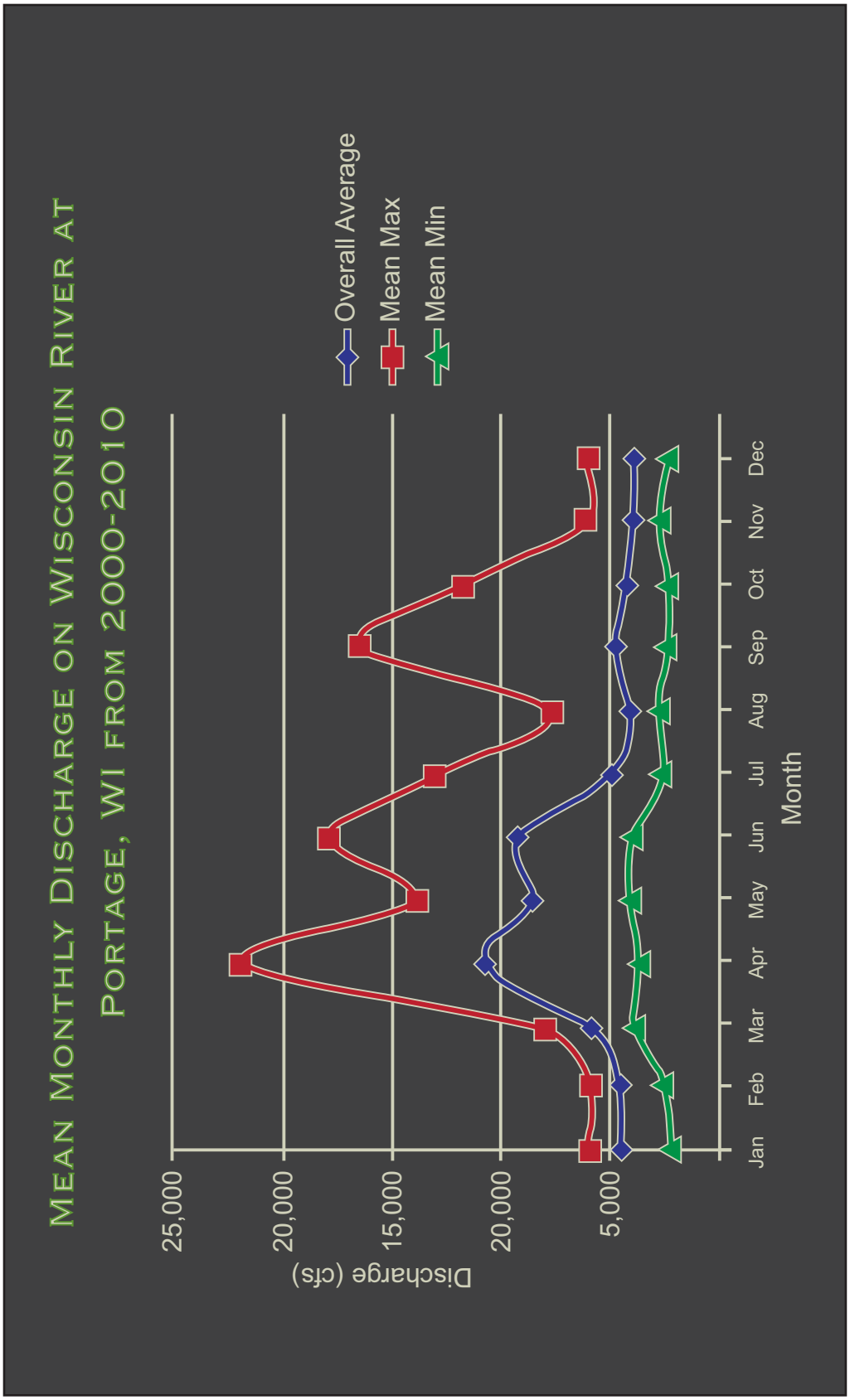

Figure 11. Monthly discharge for the Wisconsin River at Portage, WI (USGS gage no. 05404000).

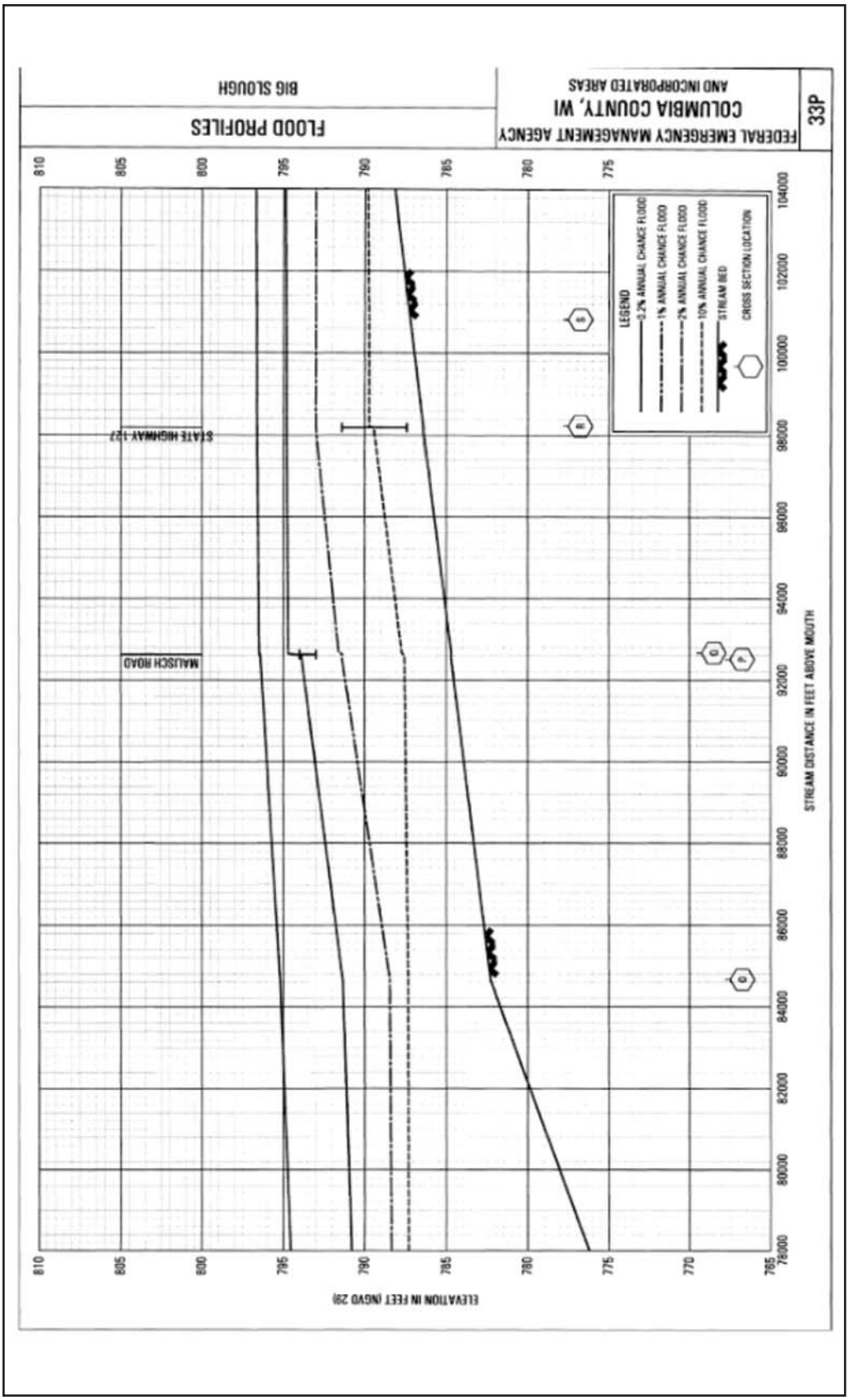

Figure 12. Longitudinal water surface profiles and stream bottom based on modeling done for the Columbia County FIS.

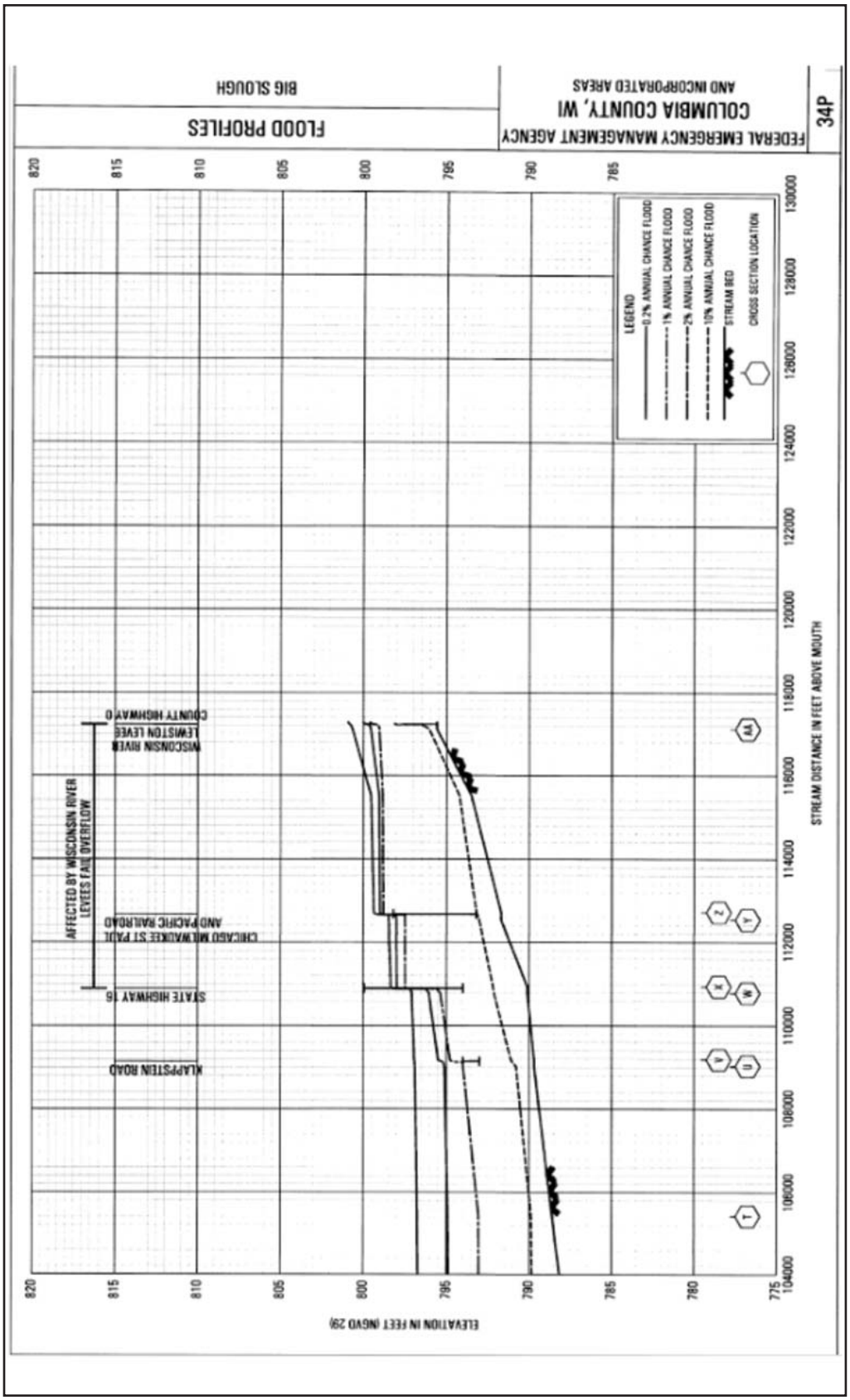

Figure 13. Longitudinal water surface profiles and stream bottom based on modeling done for the Columbia County FIS.

Table 10. Duration (days) of flooding for each of the eight events that had mean daily flows exceeding the 10 percent annual recurrence interval flood of 54,000 cfs (1,529 cms) during the time period 1935 to 2011 at the USGS gage at Wisconsin Dells. The 10 percent annual recurrence interval flood is approximately when interbasin flow begins over the Lewiston Levee at the Portage Upstream pathway Note: If the two culverts through the Lewiston Levee and County Road O are open, then interbasin flow begins earlier.

Wisconsin River at Wisconsin Dells					
Agency	**Site No.**	**Year**	**Date**	**Mean Daily Flow (cfs/cms)**	**Number of days discharge exceeded 54,000 cfs (1529 cms) in a given year**
USGS	5404000	1935	03/26/1935	58,300 (1,651)	3
USGS	5404000		03/27/1935	63,400 (1,795)	
USGS	5404000		03/28/1935	60,800 (1,722)	
USGS	5404000	1938	09/13/1938	63,200 (1,790)	4
USGS	5404000		09/14/1938	71,200 (2,016)	
USGS	5404000		09/15/1938	65,400 (1,852)	
USGS	5404000		09/16/1938	55,400 (1,569)	
USGS	5404000	1943	06/04/1943	56,900 (1,611)	1
USGS	5404000	1951	04/11/1951	58,200 (1,648)	2
USGS	5404000		04/12/1951	58,300 (1,651)	
USGS	5404000	1960	05/09/1960	58,000 (1,642)	3
USGS	5404000		05/10/1960	62,800 (1,778)	
USGS	5404000		05/11/1960	57,600 (1,631)	
USGS	5404000	1973	03/15/1973	56,300 (1,594)	6
USGS	5404000		03/16/1973	61,900 (1,753)	
USGS	5404000		03/17/1973	61,500 (1,741)	
USGS	5404000		03/18/1973	57,200 (1,620)	
USGS	5404000		04/19/1973	54,000 (1,529)	
USGS	5404000		04/20/1973	54,000 (1,529)	
USGS	5404000	1993	06/22/1993	55,100 (1,560)	4
USGS	5404000		06/23/1993	57,500 (1,628)	
USGS	5404000		06/24/1993	58,300 (1,651)	
USGS	5404000		06/25/1993	54,700 (1,549)	
USGS	5404000	2010	09/26/2010	54,200 (1,535)	2

(USGS gage at Wisconsin Dells) is presented in Table 10. Although this is not a homogenous flow record since three large hydroelectric dams upstream of Portage were constructed after 1940, and mean daily flow is not directly comparable to the peak flows given in Table 8, this provides some insight as to the duration of major flood events. This gage is located just upstream of Portage and adequately represents conditions. For these eight events, the number of days that exceeded the 10 percent annual recurrence interval flood averaged about three, with a high of six days in 1973.

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) up to a one percent annual recurrence interval storm. A surface water connection could form between the Great Lakes and Mississippi River Basins at the Portage Upstream potential aquatic pathway based on the following:

- Gravity flow at this pathway will be from the Wisconsin to the Fox Rivers.
- Although the 10 percent annual recurrence interval flood does not overtop the Lewiston levee, the hydraulic modeling indicates that overtopping begins somewhere between the ten percent and two-percent annual recurrence interval events, and probably closer to the ten percent annual recurrence interval event.
- The September 2010 flood was only slightly larger than a ten percent annual recurrence interval event based on discharge. It produced the highest recorded stage at the Portage gage and was within one or two feet (30-61 cm) of the top of the Lewiston levee.
- The culverts under County Road O could provide a connection for floods smaller than the 10 percent annual recurrence interval event.
- The Lewiston levee was not designed to standards associated with USACE FRM projects and is vulnerable to failure during flood events approaching the 10 percent annual recurrence interval flood. The floodway limits developed for the Columbia County FIS assume that the Lewiston Levee fails.

The interagency pathway assessment team determined that an aquatic connection exists between the two basins continuously for multiple days from an event with up to a ten percent annual recurrence interval. Consequently, the probability of the existence of an aquatic pathway at Portage Upstream is rated “medium” in either direction (Appendix A).

This rating is considered “very certain” based on the following:

- FEMA flood mapping has been done for this area and is up to date. The hydrologic and hydraulic analysis and modeling, and the delineation of the one percent floodplain was done to standards required by FEMA.
- Although there is uncertainty in the vertical accuracy of the topographic data, observations at this location have concluded interbasin flow occurs.
- Higher volume flows influence the connection at this location as compared to other potential aquatic pathway locations along the basin divide located higher up in the drainage basins and in headwater areas.

3.7 Aquatic Pathway Habitat

3.7.1 Terrestrial and riparian plants and land use

The Portage Upstream location is immediately northwest of the city of Portage. Land use and land cover at the site. However, is primarily agricultural, wetlands, and woodland (Figure 5 and Figure 6). The wetlands along the potential flow path are wet meadow and shallow marsh types, with little apparent open water. Wetlands are predominately vegetated with cattail and reed canary grass. The woodland and wetland habitats there would likely support a variety of wildlife species, and provide a corridor from the Wisconsin River, through the divide location to Big Slough.

The Lewiston Levee is the highest point at this divide location. The levee runs along County Rd O and is vegetated with grass (Figure 4). There are two culverts under the levee and a low point on County Road O where ANS may be able to pass during a flooding event. The distance an ANS would have to traverse from the low point in County Road O across the emergent wetlands

to Big Slough is about 2.5 miles (4 km).

Terrestrial and riparian habitat beyond the Portage Upstream divide location in the Mississippi River Basin and the Great Lakes Basin is similar to the Portage area in that it is mostly a patchwork of agriculture, woodland and wetlands. The area also includes the extensive floodplain forest of the Wisconsin River.

The terrestrial and wetland habitats at the divide location would sustain populations of wildlife that typically do not require open water to fulfill their life cycle. Numerous species would be expected to be found here, but the number of migratory waterfowl may be limited due to the lack of open water.

In addition, the U.S. Fish and Wildlife Service lists five threatened and endangered species as occurring in Columbia County: two mussel species that occur in the Wisconsin Riverand three terrestrial species that and could potentially be found in the immediate divide location.

3.7.2 Aquatic Resources

Aquatic habitat at the immediate divide location is limited. Based on a review of aerial photography, there appears to be a few open-water wetlands and basins at the divide location. It seems unlikely that these basins would be deep or large enough to reliably sustain a population of fish through the winter, and may not even be able to support most species of fish through the summer. However, more investigation of these basins would be required for an accurate assessment.

During a flood event, it is expected that the emergent wetlands at the divide location would be inundated to the point where they would be able to temporarily support most aquatic organisms. Figures 12 and 13 show the water surface profile and bottom elevation based on the Columbia County (Portage) FIS along the upper 39,000 feet (roughly 7 miles or 12 km) of this pathway. For a 10 percent recurrence interval flood event, in the reach for the emergent wetlands between County Rd O and the open-channel of Big Slough, flow depths are 0.5 to 2 feet (15-61 cm) deep, with the shallowest depths of 0.5 feet (15 cm) occurring in the Lewiston Levee and County Road O overflow areas. These depths are adequate for supporting aquatic species in this wetland complex and for providing passage over the Lewiston Levee, even for large-bodied Asian carp. Water depths increase substantially for a two percent recurrence interval flood event, making survival and passage for such an event more likely. The emergent vegetation within the pathway may hamper the passage of aquatic species at these depths, but flowing water would likely develop at least a marginal channel through the vegetation that would ease the passage of fish.

Table 10 shows that during the period from 1935 to 2011, eight flooding events have occurred that exceeded a 54,000 cfs (1,529 cms) (ten percent recurrence interval event), at which flow into the Great Lakes Basin would begin to occur. The duration of flows measuring 54,000 cfs (1,529 cms) ranged from one to six days, and averaged three days. This is very likely to be sufficient time for Asian carp to swim over the 2.5-mile (4 km) divide location, and possibly enough time for other nuisance fish species that are less mobile. It would certainly be adequate time for organisms carried on or within the water column to be passively carried over the divide.

Passage over the divide during flood events seems likely under current conditions, and that assessment assumes the Lewiston Levee and the gated culvert remain operational. Should one of these fail, the suitability of this connection for the passage of aquatic species would increase.

Unlike many other pathway sites, this pathway location is well downstream of the headwaters on the Mississippi River Basin side of the divide. This presents a unique opportunity for ANS; there is a full range of high-quality aquatic habitat available for colonization near the pathway location in the Mississippi River Basin on the Wisconsin River. The Wisconsin River at Portage is relatively large with a base flow of about 5,000 cfs (142 cms). The river at this location and upstream includes high-quality habitat types that range from lacustrine (reservoir), to riverine, to backwater and emergent wetland types. This would provide an opportunity for nearly any ANS to find suitable habitat in relative close proximity to this pathway location.

The high-quality and diverse habitat of the Wisconsin River supports a wide variety of aquatic species and is

well-known as a high-quality fishery. Fish species found there include walleye, northern pike, muskellunge, smallmouth bass, sunfishes, suckers, catfish, darters, and minnows. A wide variety of mussel species is also present, including the endangered Higgins eye (*Lampsilis higginsii*), and sheepnose (*Plethobasus cyphyus*).

The location of this pathway along a major river also presents another unique opportunity for ANS. Because of the high flows that can pass from the Mississippi River Basin to the Great Lakes Basin during a flood event, any ANS established upstream of the pathway location may be transported over the divide by floodwaters, independent of that species' mobility. This means that small or even larval fish, invertebrates, or plants can be transported over this divide location if floating on or suspended within the water column. Flow from the Mississippi River Basin to the Great Lakes Basin is estimated to be about 2,900 cfs (82 cms) for the two percent recurrence interval event (Table 9).

Aquatic habitat leading from the Mississippi River up the Wisconsin River to the pathway site is high-quality and unobstructed except for the presence of the Prairie du Sac Dam. The Prairie du Sac Dam is about 25 river miles (40 km) downstream from Portage and is a power-generating facility. There is about 38 feet (11.5 m) of head at the dam and it currently is an effective barrier to fish passage. A fish passage project is currently being designed for Prairie du Sac Dam where only desirable species (e.g., lake sturgeon, blue sucker, paddlefish) would be allowed to pass upstream. Final design plans have not yet been completed. However, the basic premises for the fish passageway have been agreed upon amongst resource agencies and the dam owner/operator. The upstream passage will be a fish lift where all fish entering the lift will be examined and sorted by trained biologists, and no Asian carp (or other ANS) will be allowed to pass upstream of the dam. The lift and fish sorting process will have detailed quality control plans and redundancy to prevent accidental passage of ANS. This will likely include three different steps where the fish will have to be examined, double checked, and manually moved between tanks before they will be released into a flume which deposits the fish into Lake Wisconsin (J. Lyons - WDNR, Personal Communication, October 9, 2012).

Aquatic habitat on the Great Lakes Basin side leading away from the pathway location is more typical of other pathway locations in that it is at the headwaters of a stream, in this case Big Slough. Big Slough drains into Neenah Creek which drains into the Fox River and then Lake Winnebago. The distance between Lake Winnebago and the divide location is about 100-120 miles (161-193 km). The Lower Fox River, connecting Lake Winnebago to Green Bay, is 39 miles (63 km) long. The USGS gage (no. 04073365) on the Fox River at Princeton, Wisconsin (about 50 miles (80.5 km) from the watershed divide) shows that the average river discharge ranges from 1,300 cfs (37 cms) in June to 550 cfs (15.6 cms) low flow in September. There are numerous dams on the Fox River that can impede upstream fish passage (Table 11, Figure 14). Big Slough is a first order stream originating in the wetland complex at the divide location.

3.7.3 Water quantity and quality

Water quantity and quality are likely limiting factors in the suitability of habitat at the immediate divide location during non-flooding periods. Based on aerial photography, there appears to be little open water within the wetland complex at the divide location, and what is available are likely to be relatively shallow wetland basins. If this is in fact the case, it is likely that these basins would experience winter freeze-out and/or winter and summer oxygen depletion problems, either of which would greatly limit their use by aquatic species.

Beyond the immediate divide location, water quantity and quality are unlikely to be limiting factors. The Wisconsin River certainly has enough water and the quality is high as evidenced by the numerous aquatic species it supports. Less is known of Big Slough and Neenah Creek, and they may in fact be unable to support fish species through the winter if they do not have enough flow to prevent complete freezing. There is no reason to believe that water quality there is degraded, except that it too may experience oxygen depletion as a result of periodic low flows. More study of Big Slough and Neenah Creek would be required to accurately assess their hydrologic and water quality characteristics. The Fox River also supports a valued fishery similar to the

Table 11. Potential Barriers to ANS Spread, Including Dam Heights, FEMA Elevations, and any Known Fish Passage (NID, 2010).

Mississippi Connection -								
	Wisconsin River, Mississippi River							
Connection	**Dam Name**	**River**	**Hydraulic Height of dam (ft) from NID**	**Dam height (ft) from NID**	**Elevation difference from tail water to dam sill from FEMA FIS Profiles**			**Fish passage?**
					10 year flood (ft)	**100 year flood (ft)**	**500 year flood (ft)**	
Mississippi	Prarie Du Sac	Wisconsin River	38	25	27	24	22	WDNR proposed fish passage project in 2015.
Great Lakes Connection -								
	Portage Upstream- Big Slough, Neenah Creek, Upper Fox River, Lake Puckaway, Upper Fox River, Lake Butte des Morts, Lake Winnebago, Lower Fox River, Lake Michigan							
	Portage Downstream- Upper Fox River, Lake Puckaway, Upper Fox River, Lake Butte des Morts, Lake Winnebago, Lower Fox River, Lake Michigan							
Connection	**Dam Name**	**River**	**Hydraulic Height of dam (ft) from NID**	**Dam height (ft) from NID**	**Elevation difference from tail water to dam sill from FEMA FIS Profiles**			**Fish passage?**
					10 year flood (ft)	**100 year flood (ft)**	**500 year flood (ft)**	
Great Lakes	* Fox River lower than Wisconsin River by about 15ft, lock channel (Portage canal) is permanently closed between the two rivers							
Great Lakes	Montello / Buffalo Lake Dam	Upper Fox River	5	13	-	0	-	Yes (fish ladder to be installed in next few years)
Great Lakes	Princeton	Upper Fox River	2	8	submerged	submerged	submerged	Yes
Great Lakes	Eureka	Upper Fox River	3	8	submerged	submerged	submerged	Yes (fish ladder)
Great Lakes	Menasha	Lower Fox River	9	16	-	-	-	through lock
Great Lakes	Neenah	Lower Fox River	9	15	-	-	-	through lock
Great Lakes	Upper Appleton Dam	Lower Fox River	14	18	-	-	-	through lock
Great Lakes	Middle Appleton Dam	Lower Fox River	10.5	11	-	-	-	through lock
Great Lakes	Lower Appleton Dam	Lower Fox River	9	19	-	-	-	through lock
Great Lakes	Cedars Lock and Dam	Lower Fox River	10	15	-	-	-	through lock
Great Lakes	Little Chute Dam	Lower Fox River	12	20	-	-	-	through lock
Great Lakes	Kaukauna Locks and Dam	Lower Fox River	13	22	-	-	-	through lock
Great Lakes	Lower Kaukauna	Lower Fox River	9	16	-	-	-	through lock
Great Lakes	Rapide Croche Lock and Dam	Lower Fox River	10	20	-	-	-	has Sea Lamprey Barrier, lock blocked
Great Lakes	Little Kaukauna	Lower Fox River	7	16	-	-	-	through lock
Great Lakes	DePere	Lower Fox River	8	17	-	-	-	through lock

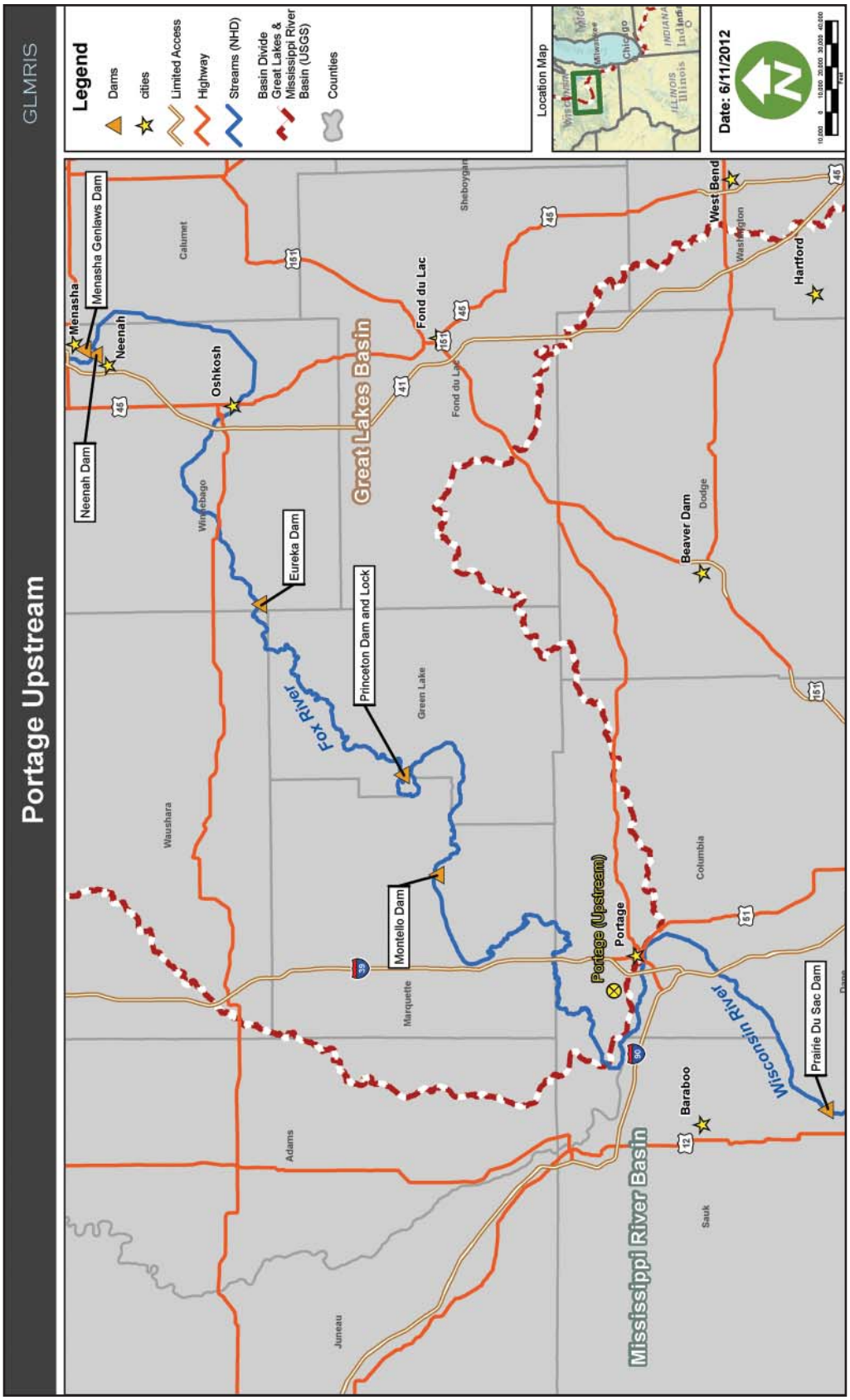

Figure 14. Location of potential barriers to ANS spread marked by orange triangles. The flow path through Portage Upstream to the Great Lakes and Mississippi River basins is marked in blue. Background imagery courtesy of Bing Maps.

Wisconsin River, and likely has suitable water quality to support most aquatic organisms.

3.7.4 Aquatic Organisms

Aquatic vegetation at the divide location appears to be dominated by cattail (*Typha* spp.) and reed canary grass (*Phalaris arundinacea*). Reed canary grass is an invasive species, and combined with cattail, can create a persistent vegetation community that may not be easily invaded by other invasive vegetation types. However, this does not mean that other aggressive invasive plant species would be unable to colonize the divide location.

The immediate divide location may not be suitable to many aquatic species due to a lack of open water. However, it does seem likely that the location would readily support and be able to pass aquatic species during larger flood events. Aquatic habitat adjacent to the divide location on the Mississippi River Basin in the Wisconsin River is diverse and of high quality and supports a multitude of aquatic species. The Fox River on the Great Lakes Basin side would also provide habitat, but is further removed from the location by two lower-order streams that would likely support a more narrow range of aquatic species long-term, but short-term survival would likely be high for most species using those streams as a pathway.

Two aquatic species are listed as threatened and endangered in Columbia County by the USFWS. These are the endangered Higgins eye (*Lampsilis higginsii*) and sheepnose (*Plethobasus cyphyus*) mussels. Both species are found in the Wisconsin River and would not be present in the immediate divide location.

3.8 Connecting streams to Great Lakes and Mississippi or Ohio River

Since it has been determined that a viable hydrologic connection between both basins can be established up to a ten percent recurrence interval flood, potential barriers to ANS spread have been identified.

The Mississippi River connection for Portage Upstream is from the Wisconsin River to the Mississippi River.

The Great Lakes Connection for Portage Upstream is:

Inundated land between Lewiston Levee and Big Slough ► Big Slough ► Neenah Creek ► Fox River ► Lake Butte des Morts ► Lake Winnebago ► Lower Fox River ► Lake Michigan

Along the flow path there are possible barriers to ANS spread (Figure 14). The Fox River and Wisconsin River longitudinal profile demonstrating the size and location of these possible barriers, is presented in Figure 15. The Portage Upstream pathway is shown in the approximate center of the figure at the break in drainage between the Lower Wisconsin River and Fox River. The possible barriers along the connecting streams to the pathway, with the hydraulic, structural, and dam heights, and whether or not there is currently fish passage allowed at each location, is presented in Table 11.

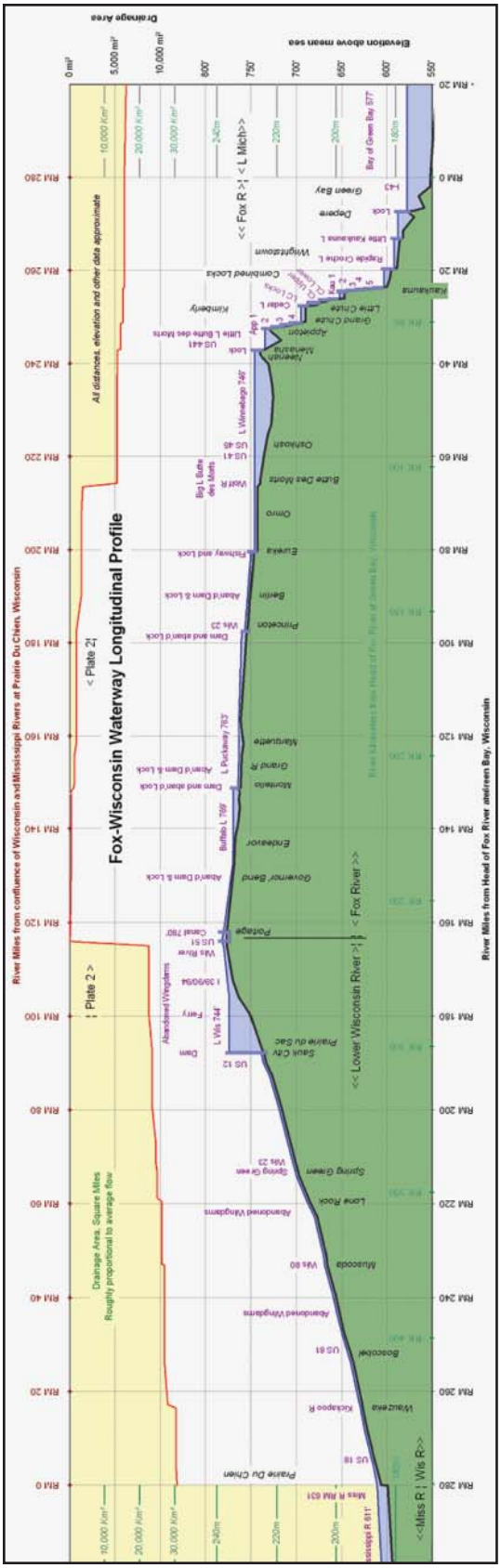

Figure 15. Longitudinal profile between Green Bay, Wisconsin and the Mississippi River, via the Fox and Wisconsin Rivers.

4 Aquatic Pathway Viability for ANS of Concern

The potential for species transfer was assessed by the project team for the ANS of concern for Portage Upstream in accordance with the procedures outlined in the Methodology Section of this report. This potential was characterized as high, medium, or low for the following categories:

- Probability that Pathway Exists (Section 3)
- Probability of ANS being within Either Basin
- Probability ANS Surviving Transit to Aquatic Pathway
- Probability of ANS Establishing at the Aquatic Pathway
- Probability of ANS Spreading across Aquatic Pathway into New Basin

The criteria for designating probabilities of high, medium, or low are provided under each category. In addition, a certainty rating is also assigned with each probability assessment. Certainty ratings associated with any given probability ratings include:

- Very Certain (As certain as we will get with this effort)
- Reasonably Certain
- Moderately Certain (More certain than not)
- Reasonably Uncertain
- Very Uncertain (An educated guess)
- A team rating is provided based on the professional collaboration of the interagency team of biologists.

These characterizations were completed by a team of agency biologists for each species under consideration. A team probability and certainty rating also is provided. The rating represents the most conservative probability assessment for each category considered. The forms describing the probability and certainty ratings from all agency professionals participating in this assessment is included at Attachment A.

4.1 Probability of the ANS Being within Either Basin

General Considerations for Assigning Probability Ratings:

High - Target ANS exists on connected waterways in close enough proximity to be capable of spreading to the aquatic pathway within 20 years.

Medium - Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of spreading to the aquatic pathway within 20 years.

Low - Target ANS is not known to exist on a connected waterway.

Certainty ratings were applied as outlined above.

Asian Carp (from MRB to GLB)

Silver carp and bighead carp are established in the middle and lower Mississippi River Basin. Single individuals have been collected at a number of places in the Upper Mississippi River Basin, but there is no evidence of successful reproduction or self-sustaining populations. Two bighead carp have been collected in the Wisconsin River below the Prairie du Sac Dam in 2011 (USGS, 2011). Silver carp have been collected in the Mississippi River well upstream of the mouth of the Wisconsin River and would likely be able to reach the Prairie du Sac Dam as evidenced by the collection of bighead carp there. However, the Prairie du Sac Dam is currently a complete barrier to Asian carp upstream movement and prevents them from reaching the Portage area. However, discussions with WDNR

indicate that there is a proposed fish passage project at this dam being designed, which is discussed in greater detail under Asian carp in the following section. Black carp likely have a more limited distribution and are less likely to reach the Prairie du Sac Dam in the near term.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Inland Silverside (from MRB to GLB)

The inland silverside's native range is eastern North America, including the Atlantic and Gulf Slopes (mostly near the coast) from Massachusetts to the Rio Grande drainage, Texas and southeastern New Mexico; north from the Mississippi River and major tributaries (mainly Arkansas and Red Rivers) to southern Illinois and eastern Oklahoma (Page and Burr, 1991). It is a marine species that ascends rivers and prefers estuaries, lagoons, brackish seas, and rivers (Fishbase, 2011). Inland silversides have not been collected in the Wisconsin River. Recently, its most northern known occurrence in the Mississippi River Basin is on the Kankakee River in Will County Illinois, where they were collected in 1996 (Fuller and Nico, 2012a; USGS, 2011). The species was stocked in Turtle Lake in Ramsey County, Minnesota in 1950, but that population failed. The species has also been collected in Illinois from Lake Baldwin, Lake of Egypt, Rend Lake, Cache River, Wabash River, and the Mississippi, Ohio, and Kankakee Rivers (Laird and Page, 1996). It is believed that the presence of the species in the Mississippi River in southern Illinois and in the lower Ohio River in Illinois and Kentucky are a result of natural dispersal (Fuller and Nico, 2012b).

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Northern Snakehead (from MRB to GLB)

The closest established population of northern snakeheads is in Lee County, Arkansas. While this is in the Mississippi River Watershed, this population does not seem to be spreading at a high rate at this time (USGS, 2011). A single specimen of giant snakehead (Channa micropeltes) was collected in the Rock River by the WDNR (a watershed not directly connected with the Portage Upstream pathway). This specimen was unintentionally released. However, the species is considered to be tropical to sub-tropical and not able to survive winter temperatures encountered in the Rock River (Courtenay, Jr. and Williams, 2004).

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Scud (Apocorophium lacustre (from MRB to GLB)

This is a crustacean that is native to the Atlantic coast of North America and is established in the Illinois River Basin (USGS, 2011). It does not densely populate the Mississippi River Basin, but it can be locally abundant. It was first reported in the Lower Mississippi River in 1987-1988, and then later found in the Ohio River in 1996, and it moved 714 miles (1,150 km) up the Ohio River within a year, likely due to shipping (Grigorovich, et al., 2008). It is currently unknown to exist in the Great Lakes Basin. The species is unable to move upstream significant distances under its own power, so it is unable to use the Mississippi River as a waterway to move into the Wisconsin River.

Team rating: **Medium**
Team certainty rating: Moderately Certain

Plant ANS (from MRB to GLB)

Plant ANS are being evaluated for the Portage Upstream site because of its unique geographic position in the watershed in that it is not at the upper headwaters of the two drainage basins. Instead, it occurs along the Wisconsin River at point with a large upstream drainage area. This results in the potential for upstream floodwaters in the Wisconsin River Basin to flow into the Great Lakes Basin, thereby permitting any material, including plant material, to be carried to and over the divide by floodwaters. It also means that there is a large source area upstream of the divide location that can be colonized by ANS, and provide a consistent source of ANS material during floods.

Three plant species that were listed as being of concern to the Great Lakes Basin include dotted duckweed, marsh dewflower, and Cuban bulrush. Additional plant species have also been determined to be of concern by professionals in the field, but for the purpose of

this assessment all are being treated collectively as nuisance plant species. Only those species found in the Mississippi River Basin but not in the Great Lakes Basin have been considered because water from the Great Lakes Basin would not flow into the Mississippi River Basin except possibly under extremely rare occasions. None of the three listed species have been found in Wisconsin, but dotted duckweed is the species in closest proximity, having been established in Senachwine Lake in Bureau County, Illinois (Illinois River drainage) since 1986 (Jacono, 2002). Dotted duckweed has a high rate of vegetative propagation and mainly occurs via vegetative budding of daughter fronds from two pouches at the base of the frond (Jacono, 2002). It is native to Australia and Southeast Asia, and thrives in nutrient rich waters and prefers slow moving or stagnant ponds (Jacono, 2002). It is frequently found in stagnant small ponds, ditches rich in organic matter, or near sewer outlets (Hillman, 1961). Marsh dewflower was reported in Louisiana in the 1920's but has not spread very far up the Mississippi River (Dunn and Sharitz, 1990a).

Team rating: **Medium**
Team certainty rating: Reasonably Uncertain

Viral Hemorrhagic Septicemia Virus (from GLB to MRB)

Viral hemorrhagic septicemia virus (VHSv) can infect a wide range of host fish causing a variety of external and internal pathology including death of the host fish. Variables such as host fish species and water temperature can impact the pathology of the virus. Seemingly healthy individuals that have been previously infected with VHSv can have chronic infections and be carriers of the disease (Skall et al., 2005). This virus has been reported from throughout the Great Lakes Basin including Lake Michigan and was found in Lake Winnebago in 2007, but not since (USGS, 2011).

VHSv has been found in many species of fish including common carp (*Cyprinus carpio*). The common carp is established in Lake Michigan, as well as the Fox River leading to the divide. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species for VHSv because of the life cycle capabilities of the common carp, and the likelihood the common carp could use and survive in the pathway habitats. VHSv and a necessary host species, the common carp, are in the pathway. It should also be noted that VHSv has been found in 28 different host fish species in the Great Lakes Basin and that it can survive without a host in the water column (WDNR, 2012b).

Carp from Lake Winnebago have access to the Upper Fox (although several low-head dams along the way provide substantial barriers), but the river is warm, and it is uncertain whether VHSv could persist in the system even if infected fish swam up the Fox River from Lake Michigan.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Ruffe and Tubenose Goby (from GLB to MRB)

The ruffe and tubenose goby are located within the Great Lakes and are associated with river mouths and estuaries of large river systems entering the Great Lakes. The ruffe exists in northern Lake Michigan in Green Bay, but is not widespread and there are no high density populations in Lake Michigan (Bowen and Goehle, 2011). The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravel but has a tolerance for different habitats and environmental conditions (Gray and Best, 1989). The ruffe has a high reproductive rate and spawns in clean water. Females produce up to 200,000 eggs in the first batch, and up to 6,000 eggs per subsequent batch (Global Invasive Species Database, 2012). The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures and turbid conditions. The ruffe has extended its range rapidly and modeling predicts it will find suitable habitat in all five Great Lakes (USGS, 2012). The Tubenose goby is a benthic species that consumes a wide variety of invertebrates (USGS, 2011). They are found in the open waters and estuaries of slow flowing rivers and are often quite abundant in backwaters and lakes, and seem to prefer dense vegetation. The tubenose goby's introduced range covers three Great Lakes including Lake Superior, Erie, and Huron (USGS, 2011). It has been collected in the lower reaches of larger Great Lakes rivers and estuaries, but no tubenose goby have been collected locally in the tributary rivers of the upper Great Lakes to date. Tubenose gobies have

exhibited a much slower rate of expansion in the Great Lakes than the round goby (Neogobius melanostomus), also an invasive species in the Great Lakes and now located within both the Great Lakes Basin and the Mississippi River Basin. The tubenose goby's nearest locations are in Lake Superior and Lake Huron.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Threespine Stickleback (from GLB to MRB)

The threespine stickleback is found in each of the Great Lakes and has been collected in some inland river systems (USGS, 2011). Literature indicates this species prefers to live in smaller streams but may occur in a variety of habitats including lakes and large rivers. The threespine stickleback was first encountered in lower Green Bay and the Lower Fox River (below DePere Dam) about 25 years ago, but has never been seen upstream from this area. Great Lakes populations of this species tend to be potamodromous (truly migratory but within fresh water only) and only enter the lower reaches of streams briefly during spring spawning.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

4.2 Probability Target ANS Survives Transit to Aquatic Pathway

4.2.1 Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

General considerations for assigning probability ratings:

> **High** - Target ANS are established in relatively close proximity to the location and have ample opportunity, capability, and motivation to successfully navigate through the connecting streams to arrive at the subject pathway within 10 to 20 years.
>
> **Medium** - Target ANS are established at locations in close enough proximity to the location and have limited capability to survive spreading through the connecting streams to arrive at the subject pathway within 20 to 50 years.
>
> **Low** - Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations through the connectin streams to arrive at the subject pathway within next 50 years.

The same certainty ratings identified above also apply here.

Asian Carp (from MRB to GLB)

An aspect that may slow the rate of Asian carp expansion toward the Portage Upstream Pathway is that these fish need long free-flowing reaches of stream to spawn that is initiated by rising water levels following heavy rains. Bighead and silver carp need 35-40 miles (56-64 km) of open river to successfully spawn (Jennings, 1988; Verigin, 1978; Nico and Jelks, 2011). While silver and bighead carp are highly opportunistic on their diet, bighead carp are primarily zooplanktivorous, whereas silver carp primarily consume smaller phytoplankton and fine particulate organic matter (Dong and Li, 1994; Jirasek et al., 1981; Williamson and Garvey, 2005). Adult black carp are primarily molluscivores. However, they will opportunistically consume a wide variety of food items (USFWS, 2002). Juvenile black carp have a diet more similar to silver and bighead carp, consisting primarily of zooplankton (USACE, 2011b). The diet of juvenile black carp may allow them to survive in areas unsuitable for adults. The habitat of black carp is very similar to the grass carp (*Ctenopharyngodon idella*) (Nico and Jelks, 2005). It is believed that black carp should be able to colonize the same areas of the United States where the grass carp have established (USFWS, 2002).

However, the exact dispersal capability of these species

remains unknown. Juvenile, sexually immature Asian carp have been observed in the upmost reaches of small tributaries to large rivers attempting to pass over barriers, such as dams, to continue their upstream movement (D. Chapman, personal communication, September 12, 2011; N. Caswell, U.S. Fish and Wildlife Service, September 12, 2011). The gradient needed to prevent juvenile fish from moving upstream is unknown. It is important to note that young Asian carp tend to move laterally away from the river in which they were spawned and not back upstream (D. Chapman, personal communication, September 12, 2011). It has also been observed that Asian carp, as small as advanced fingerlings, have traveled up to 37 miles (60 km) through tributaries of the lower Missouri River. These tributaries were located laterally to the Missouri river segment in which these fish hatched (D. Chapman-USGS, personal communication, September 12, 2011). Adult, sexually mature Asian carp have occasionally been found in very small streams, which appear scarcely large enough to support the fishes at low water (D. Chapman, personal communication, September 12, 2011). The age of these fish when they arrived at these locations is unknown. While ongoing research by Indiana Department of Natural Resources and Purdue University may suggest that tagged Asian carp have no interest in ascending some of the smaller rivers, more long term studies are needed, and even these may not help explain the seemingly random movements of juveniles that have been witnessed in Midwestern rivers and their tributaries (Coulter and Goforth, 2012; D. Chapman, personal communication, September 12, 2011).

Passage of Asian carp upstream of the Prairie du Sac Dam is unlikely because it is reported to currently be a complete fish barrier by the WDNR due to its high hydraulic head (38 feet or 11.6 m) and lack of fish passage. However, fish passage at this dam is planned for construction with an estimated completion date of 2015. Final design plans for fish passage at Prairie du Sac Dam have not yet been completed. However, the basic premises for the fish passageway have been agreed upon amongst resource agencies and the dam owner/operator. The upstream passage will be a fish lift. All fish entering the lift will be examined and sorted by trained biologists and no Asian carp (or other ANS) will be allowed to pass upstream of the dam. The lift and fish sorting process will have detailed quality control plans and redundancy to prevent accidental passage of ANS. This will likely include three different steps where the fish will have to be examined, double checked, and manually moved between tanks before they will be released into a flume which deposits the fish into Lake Wisconsin (J. Lyons - WDNR, Personal Communication, October 9, 2012). Operation of this fish passage to only pass desirable species (e.g., paddlefish, blue sucker, lake sturgeon) would nearly eliminate it as a potential vector for Asian carp to move upstream of the Prairie du Sac Dam. The results of this pathway assessment are being shared with WDNR for their consideration in the final design and operation of this proposed fish passage project.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Inland Silverside (from MRB to GLB)

The inland silverside moves in large schools that can number in the thousands and they can travel far up streams and rivers, especially in southern part of their range (NatureServe, 2010). The species' natural spread rate through the Mississippi River Basin is not known because they have been actively stocked in lakes. The average lifespan of the inland silverside is about 16 months, with few surviving their second winter (NatureServe, 2010). It is capable of producing 30,000 eggs per month (Stoeckel, 1988). The ability of this species to reach the divide at Portage Upstream is low for at least two reasons. First, it has apparently been unable to successfully colonize in areas in the upper Mississippi River Basin beyond where it has been stocked, and stocking had failed at Turtle Lake in Minnesota. Second, as a small fish it is unlikely to be able to move great distances upstream to the Prairie du Sac Dam.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Northern Snakehead (from MRB to GLB)

The Arkansas population of the northern snakehead could expand into and up the Mississippi River. However, there are many barriers to movement including dams on the river and its tributaries. Habitat preferred by

northern snakeheads includes stagnant, shallow ponds or swamps with mud substrate and aquatic vegetation, and slow muddy streams (Courtenay and Williams, 2004). The northern snakehead likely possesses the ability to spread through portions of interconnecting tributary streams. However, its preferred habit is not flowing waters, which will likely slow its spread up the Mississippi River and its tributaries. Unlike the Asian carp, northern snakeheads do not make long upstream spawning runs and as a result, are not likely to spread quickly through the Mississippi River Basin without the aid of anthropogenic means. The main stem of much of the Mississippi River may not provide adequate habitat to this species to maintain a viable population to attempt a spread towards the Great Lakes.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Scud (from MRB to GLB)

The species is not in proximity to the pathway and is small and minimally mobile and, therefore, does not likely have the ability to spread upstream to the pathway under its own power in the next 50 years. While upstream dispersal has been observed on the Illinois River (USACE, 2011b), it is unlikely that this species can move upstream significant distances under its own power. It is not found in fast flowing or turbid water and typically moves downstream, not upstream (Grigorovich, et al., 2008).

Team rating: **Low**
Team certainty rating: Moderately Certain

Plant ANS (from MRB to GLB)

As discussed above, it is highly unlikely that a plant ANS would reach the divide location without assistance from some non-aquatic vector in the next 50 years. However, some ANS plant species such as the marsh dewflower exhibit vigorous growth and can spread by root fragments during flood events (Swearingen, 2010). However, expansion in the Southeastern United States has been slowly over many decades (Dunn and Sharitz, 1990b). Dotted duckweed is in closest proximity to Portage, Wisconsin but in the Illinois River Watershed in Illinois. Dotted duckweed was first documented in Missouri in 1934 and is now well naturalized in the southeastern United States. It is a tiny free floating plant that is distributed easily and colonizes quickly (Jacono, 2002). Dotted duckweed may be limited due to its sensitivity to severe frosts and the plants are not known to survive cold temperatures (e.g., 0º C for several weeks) (Jacono, 2002; Landolt, 1986).

Team rating: **Low**
Team certainty rating: Reasonably Certain

Viral Hemorrhagic Septicemia (VHSv) (from GLB to MRB)

From Lake Winnebago to the watershed divide at Portage Upstream along the Upper Fox River is approximately 100-120 miles (161-193 km). The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles (63 km). The USGS gage (no. 04073365) on the Fox River at Princeton, Wisconsin (about 50 miles (80.5 km) from the watershed divide) shows average river discharge ranges from 1,300 cfs (37 cms) in June to 550 cfs (16 cms) low flow in September.

Viral hemorrhagic septicemia virus has been identified in Lake Winnebago and so has the common carp, which is also present in the Fox River. Infected common carp, as a potential carrier of VHSv (and potentially the parasitic copepod), have not been identified within the Upper Fox River. Common carp are strong swimmers that can reach sustained speeds of 1.3-3.9 fps (0.4-1.2 mps) and burst speed of 3.9-8.5 fps (1.2-2.6 mps). Though they cannot jump (maximum height six feet or 1.8 m) like members of the salmon family, they can swim upstream during moderate flow events. The lock and dam system and dam heights on the Fox River appear to be insufficient to prevent the upstream spread of fish from Lake Winnebago that could carry VHSv, and VHSv could reach the divide location assuming it is still present in Lake Winnebago.

There would be less risk of VHSv reaching the divide, if the virus was no longer present in Lake Winnebago, because fish cannot readily reach Lake Winnebago from Lake Michigan because of the permanently closed lock at the impassable Rapid Croche Dam on the Lower Fox River. However, the dam may be passable by common carp during a 10 percent annual recurrence interval

flood event with the difference in elevation between the sill and tailwater at five feet (1.5 m) and less than 3.9 fps (1.2 mps) velocity. At the one percent recurrence interval discharge event, the velocity is 11 fps (3.4 mps) with a tailwater elevation difference of 3 feet (0.9 m) which is not considered to be passable by fish.

During spring run-off events in April and May, common carp move into the shallow waters of bays and river systems to spawn. At flood stage, the Wisconsin River waters would cross the Portage Upstream divide by sheet flow over the Lewiston Levee and County Road O, traveling more than a mile (1.6 km) across farm fields or emergent wetlands to the Great Lakes Basin. The lack of a direct ditch connection for flowing waters from the Mississippi River Basin to the Great Lakes Basin minimizes the probability of invasive species transfer from the Great Lakes Basin to the Mississippi River Basin during an overflow event. However, if sufficient water depths of a foot (30 cm) or more were maintained in the farm fields or the wetlands on both sides of the low point over County Road O for a few days during spring spawning season, common carp could possibly find a path through the flooded divide and the roadside ditches and into the Mississippi River Basin. If the road or levee washed out during a large storm event, the probability of fish passage over the divide would increase. If common carp were present in the Fox River during a spring runoff event of sufficient duration, it is possible that the infected carp could transfer to the Mississippi River Basin. The farm and wetland divide provide the primary basis for the level of certainty rating assigned to this location for this specific ANS, represented by the common carp as the host fish for VHSv.

Team Rating: **Medium**
Team Certainty Rating: Reasonably Certain

Ruffe and Tubenose Goby (from GLB to MRB)

From Lake Winnebago to the watershed divide at Portage along the Upper Fox River is approximately 100-120 miles (161-193 km). The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles (63 km). The USGS gage (no. 04073365) on the Fox River at Princeton, Wisconsin (about 50 miles (80.5 km) from the watershed divide) shows average river discharge ranges from 1,300 cfs (37 cms) in June to 550 cfs (15.5 cms) low flow in September. The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravel areas, but has a tolerance for different habitats and environmental conditions (Gray and Best, 1989). Ballast water transport has been the key means for the spread of ruffe in the Great Lakes (USFWS, 1996). Natural rates of dispersion are not well known and ruffe have not spread beyond Green Bay in the nine years since its detection in that area, and populations have been trending down (Bowen and Goehle, 2011). The ruffe's ability to swim upstream during high flow events and pass over dams is questionable, especially since it prefers still or slow moving water (Fishbase, 2011). The vicinity of the divide within the Great Lakes Basin , consisting of more than a mile (1.6 km) wide emergent and forested wetland complex and some agricultural land off the Fox River, appears to be a barrier to further movement toward the divide. The flooded farm land, or emergent/forested wetland complex, is not a preferred habitat for either the ruffe or the tubenose goby and the likelihood of either fish species crossing farm fields or emergent wetlands during a flood event is considered low as the flow of water is from the Mississippi River Basin to the Great Lakes Basin.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Threespine Stickleback (from GLB to MRB)

The threespine stickleback has been found in the Great Lakes and in smaller river systems. While not having been identified within the Upper Fox River, its close proximity in the Great Lakes indicates potential for access and transfer to the Mississippi River Basin. Section 2.7 describes the dams as potential obstacles to upstream movement to the basin divide. Sufficient forage and habitat appear to be available throughout the Upper Fox River for the threespine stickleback. However, the literature does not indicate a propensity to swim upstream during runoff events and it is unlikely that this species would reach the basin divide at Portage Upstream by natural means. The mile (1.6 km) wide farm field and emergent wetland should be sufficient in impeding spread of the threespine stickleback at all flow conditions as flooded farm field and emergent wetland is not a preferred habitat. However, the fish could potentially survive in the emergent wetland divide during a storm runoff event as they are tolerant of low

dissolved oxygen down to two parts per million (ppm) and temperatures up to 68ºF (20ºC) (Wootton, 1976).

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

4.2.2 Probability of ANS Surviving Transit to Aquatic Pathway through Other Means

The ratings in this section do not influence the overall pathway rating outlined in this report, and are only included to point out potential other pathways (e.g., anthropogenic) and their potential influence on the same list of ANS as evaluated in Section 4.2.1. Any further analysis of these non-aquatic pathways outside of this study should develop a separate list of ANS that will likely differ from those which may exploit the aquatic pathway.

General considerations for assigning probability ratings:

> **High** - Target ANS are established in relatively close proximity to the location and have ample opportunity, capability, and motivation to successfully navigate through a non-aquatic pathway to arrive at the subject pathway within 10 to 20 years.
>
> **Medium** - Target ANS are established at locations in close enough proximity to the location and have limited capability to survive spreading through a non-aquatic pathway to arrive at the subject pathway within 20 to 50 years.
>
> **Low** - Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations through a non-aquatic pathway to arrive at the subject pathway within next 50 years.

The same certainty ratings identified above also apply here.

Asian Carp (from MRB to GLB)

The probability of Asian carp arriving at the pathway through other non-aquatic means is higher than aquatic vectors due to the large area upstream of the Prairie du Sac Dam and the Portage Upstream location, and the high recreational use of the Wisconsin River and its flowages there. This could result in accidental bait bucket transfers of juvenile Asian carp, though the recurrence interval of such a transfer seems small because carp grow quickly and would likely be mistaken for bait only when very young. A greater consideration in this rating is the fact that there is a large and accessible area of river and flow upstream of the Prairie du Sac Dam, which would increase the potential for intentional or accidental releases of Asian carp. These flows would provide suitable habitat for the fish and any established population of Asian carp there would likely have continuous access to this pathway location because most dams do not substantially inhibit the downstream spread of fish. Asian carp are a specifically prohibited species by name in Wisconsin, which would help prevent the intentional or unintentional release of fish.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Inland Silverside (from MRB to GLB)

The likelihood that this species reaches the basin divide at Portage Upstream through non-aquatic means such as bait bucket transfer was also rated low due to the inland silverside's absence in Wisconsin. However, the certainty of this rating is based on the assumption that bait bucket transfer would still be possible due to the high recreational use of the Wisconsin River, even though this species is prohibited under Wisconsin law (NR 40.02(17)). The WDNR has indicated that silverside mortality is high in normal bait buckets.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Northern Snakehead (from MRB to GLB)

It is also more likely that this species would be transported to the pathway location by non-aquatic means. Bait bucket transfer seems unlikely due to the snakehead's

size and physical appearance (it does not look like a bait species), though young-of-year snakeheads could be more easily mistaken for baitfish. However, there is a possibility that the species would be released into waters intentionally, as has been the case in other introductions in the U.S. There is a large area of the Wisconsin River and its flow upstream of the pathway location is easily accessed by the public. The certainty of such a release is only moderate, because numerous efforts have been made to prevent such releases from happening, including the fact that the species is prohibited under Wisconsin law (NR 40.02(17)).

Team Rating: **Medium**
Team Certainty Rating: Moderately Certain

Scud (from MRB to GLB)

There is a large area upstream of the pathway that is heavily utilized for recreation, and it is possible for the species to be carried from its current location to the Wisconsin River in water within recreational vessels or in bait buckets, as it can readily be transported by attaching to boat hulls (Grigorovich, et al., 2008).

Team rating: **Medium**
Team certainty rating: Moderately Certain

Plant ANS (from MRB to GLB)

There is a reasonable certainty that an ANS plant species could be introduced to the divide location by non-aquatic means, either natural or anthropogenic, within the next 20-50 years. The fact that there is a large area upstream of the divide location that could be colonized by plant ANS, and those plant colonies could then provide a continuous source of plant material to the divide location is of major importance at this site. Any of these species could be transported to or upstream of the divide location through recreational boats and trailers. Education is an important factor in reducing human transport, and this vector is not hampered by watershed divides.

Dotted duckweed is a small, inconspicuous duckweed species which could be unintentionally transported by boats or trailers traveling into Wisconsin from surrounding states (Lembi, 2009). It could also be spread through the migration and movement of waterfowl or small mammals (ISSG, 2006; Jacono, 2002). Marsh dewflower and Cuban bulrush also produce both seeds and vegetative fragments which could be transported by human or animal means. However, neither species is currently reported from any states in close proximity to Wisconsin. At least one of these species, the Cuban bulrush, can also be transported in the gut of migratory birds.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Viral Hemorrhagic Septicemia Virus (from GLB to MRB)

There is no evidence or information to suggest the farm fields or emergent wetland at the divide are recreational areas used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this location by anthropogenic means. Furthermore, in the unlikely event an infected common carp is introduced into the divide, the aquatic habitat is considered marginally suitable for survival of the host common carp for at least the summer during most years. While the common carp is a very tolerant fish, survival of infected carp in the pond through the late summer when water temperatures in the small water bodies become elevated and dissolved oxygen content diminishes, is considered unlikely. Establishment of VHSv within the divide is considered low. These considerations were the primary basis for the assignment of a low rating to the probability ANS will survive transit to the aquatic pathway by other means.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Ruffe and Tubenose Goby (from GLB to MRB)

There is no evidence or information to suggest the farm fields or emergent wetlands at the divide are recreational areas used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this location by anthropogenic means. Further, in the unlikely event these fish are introduced into the divide, the aquatic habitat is considered marginally suitable for survival

of the ruffe or tubenose goby for at least the summer during most years. Transit across the watershed divide by other anthropogenic means is possible but unlikely because fishing and recreational boating do not occur at the divide. The ruffe and tubenose goby are listed among the "established nonnative fish species" (see WDNR 40.02(17)), which is one of four groups of "restricted" non-native fish species. Fish species in this restricted group may not be possessed, transported, transferred, or introduced without a permit from the WDNR. While it is feasible that either species could arrive at the divide by anthropogenic means, such as livewell or aquarium releases, this is also unlikely as these two fish species are not normally used as live bait for river fishing or aquarium species.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Threespine Stickleback (from GLB to MRB)

The threespine stickleback can tolerate dissolved oxygen levels as low as two ppm at 68ºF (20ºC), which might not be met at all connecting waterways to the Portage Upstream site in late summer. There is no evidence or information to suggest the emergent wetland is a recreational area used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this location by anthropogenic means. It is believed that bait-bucket transport has aided in the movement of the threespine stickleback in the past. The threespine stickleback is listed among the "established nonnative fish species" (see WDNR 40.02(17)), which is one of four groups of "restricted" non-native fish species. Fish species in this restricted group may not be possessed, transported, transferred, or introduced without a permit from the WDNR. Since fishing and boating are not recreational uses that occur at the divide, it is unlikely that the species would arrive at the divide by anthropogenic means. If the fish were dumped into either the Wisconsin or the Upper Fox River, it is likely they would survive and spread downstream. Education will be critical to minimize accidental introductions through this pathway, thus the rating and certainty.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

4.3 Probability of ANS Establishment at the Aquatic Pathway

General Considerations for Assigning Probability Ratings:

> **High** - Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range, and there are no known predators or conditions that would significantly impede survivability or reproduction.
>
> **Medium** - Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
>
> **Low** - Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive. There is very limited available habitat area suitable for ANS cover, sustainable food supply, and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

Asian Carp (from MRB to GLB)

Silver and bighead carp are fast growing species that are capable of surviving a wide range of water temperatures and reproducing quickly, provided that suitable habitat is available. Life history and habitat requirements generally include diverse needs for current areas, backwater habitats, deep overwintering holes, and other habitat types needed for survival (Nico, et al., 2005). Silver and bighead carp require sufficient flow to keep fertilized eggs suspended for successful reproduction (Gorbach and Krykhtin, 1980). It is unlikely that Asian carp would be able to survive for long periods of time on the pathway because it is a shallow wetland

habitat that would likely freeze-out during winter, or reach high temperatures with low oxygen levels during the summer. However, it seems more likely that these species would be able to survive on the Wisconsin River in proximity to the pathway, as it would likely provide suitable habitat for adults and may even provide habitat for spawning and rearing in some reaches.

Team Rating: **Medium**
Team Certainty Rating: Reasonably Certain

Inland Silverside (from MRB to GLB)

As a size-selective planktivore, the inland silverside relies primarily on sight for feeding, which could be limited within and around the wetlands at the divide (Elston and Bachen, 1976). The divide location would likely be unable to support the species because of winter freeze-out and/or low dissolved oxygen levels in the summer. Hubbs, et al. (1971) inferred that the native inland range for the inland silverside does not extend beyond the confluence of the Ohio and Mississippi Rivers because it cannot withstand winters farther north. However, Richards (1977) showed that the inland silverside can survive for at least two weeks at 34.7ºF (1.5ºC). Stoeckel and Heidinger (1988) demonstrated that inland silversides can be maintained over winter in aquaculture systems at temperatures above 59ºF (15ºC), when they were fed a prepared diet. They also demonstrated that inland silversides have a high mortality during extended periods of cold during the winter in unheated ponds and reservoirs. Overwintering mortality in the 80-90 percent range has been reported for the inland silverside in Rhode Island waters (Bengtson, 1982). Currently there are no records of established populations at this latitude. Spawning occurs in shallow water in areas with abundant vegetation, and includes all forms of plants, including dead leaves, tree roots, algal mats, or rooted aquatic plants of marshes (Hildebrand, 1922; Weinstein, 1986). The lack of quality habitat for this species at these basin connections would make it difficult for this species to colonize and become established in this location. The Wisconsin River at this location may have suitable habitat, but the site may be too far north for the species to survive, which is supported by the lack of successful populations being reported this far north, even after intentional stocking. It is possible that individuals could pass through the pathway during flood events, but this would be less likely than with larger more mobile fish species.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Northern Snakehead (from MRB to GLB)

The northern snakehead's native range (latitude 24-53º N) and temperature tolerance 32º F-86º F (0-30º C) indicates a species that, if introduced, could establish populations throughout most of the contiguous United States (Courtenay, Jr. and Williams, 2004). Northern snakeheads are naturally aggressive predators that could easily acclimate to the conditions in and around the wetland divide as long as there is an ample food supply. They prefer shallow ponds and marshes with aquatic vegetation, which is similar to the aquatic habitat at the wetland divide. The snakehead's preference for shallow aquatic and wetland habitats, coupled with its ability to breathe air, make it more possible for this species to colonize the deeper wetlands in the divide location. It still may succumb to winter freeze-out, but it does have the ability to survive under the ice. Food may be a limiting factor for the establishment of a population here. The propensity for this species to quickly move through an area such as the divide during flooding is less certain, though the species is not known for moving long distances. This species is not known to readily move over dry land in response to declining water levels as are some species of snakehead.

Team Rating: **Medium**
Team Certainty Rating: Reasonably Certain

Scud (from MRB to GLB)

Suitable habitat includes rocky and/or sandy shoals (Angradi, 2009; Grigorovich, et al., 2008). It seems likely that, if introduced, the species would be able to colonize waters near the pathway. The scud appears to have successfully established throughout the Illinois River, and the pathway location is within the latitudinal limits of its native range. The scud is also tolerant of a wide range of temperatures based on its current distribution (Ysebaert, et al., 2000). It is less certain that it would be able to colonize the wetlands at the divide location.

Team rating: **Medium**
Team certainty rating: Moderately Certain

Plant ANS (from MRB to GLB)

If a plant ANS were to become established at or above the pathway location, it would likely be able to colonize the divide location or at the very least be able to be carried to the divide location by floodwaters. The wetland habitat found at the divide location would likely be suitable for at least one, if not all, of the target plant ANS of concern for this site. At a 50-year event, there would be about 2,900 cfs (82 cms) flowing from the Wisconsin River to the Great Lakes Basin. This amount of flow would easily carry plant material into the divide location. This would especially be true for floating material such as dotted duckweed, marsh dewflower, or the floating achenes of the Cuban bulrush. However, the ability of these species to grow and overwinter in Wisconsin would play an important factor in whether they would be able to establish a sustainable population. Dotted duckweed exhibits a low winter tolerance and is unable to form turions (over-winter buds) like many of our native duckweeds (Jacono, 2002). The native and current adventive range of Cuban bulrush is tropical to sub-tropical in climate (Bryson et al., 2008), and little is known about its basic biological and ecological characteristics. Marsh dewflower is most prevalent in the southeastern United States, although some sparse populations have been reported in the temperate climates of the Pacific Northwestern U.S. (Christy, 1994), and its survival ability in Wisconsin is uncertain. Habitats of marsh dewflower include forested, emergent, and shrub scrub wetlands (Bason, 2004).

Team rating: **Medium**
Team certainty rating: Reasonably Certain

Viral Hemorrhagic Septicemia Virus (from GLB to MRB)

During spring run-off events in April and May, common carp disperse into the shallow waters of bays and river systems to spawn. Within the rivers, common carp move upstream to spawn in suitable habitat such as marshes and even drainage ditches and emergent wetlands with as little as or less than one foot (30 cm) depth of water. Common carp are strong swimmers and though they cannot jump like members of the salmon family, they can move upstream during moderate flow events. Survival and reproduction of common carp as a potential carrier of VHSv is considered fairly good at this location during the spring. During spring runoff, the wetland divide, and connecting ditches and streams would provide the necessary habitat for occupation of any VHSv carrier or host fish species, at least temporarily. The adjacent rivers provide suitable habitat for all life stages of the common carp. The virus is capable of persisting outside of a host in the water column for at least 14 days and grows best in fish when water temperatures are 37º F - 54ºF (2.8ºC - 12.2ºC). It also demonstrates a rapid reproductive cycle and is capable of utilizing up to 28 known fish species in the Great Lakes Basin, including common carp (WDNR, 2012b). These considerations were the primary basis for the medium rating assigned to the probability that VHSv could become established in close proximity to the upper Portage divide.

Team Rating: **Medium**
Team Certainty Rating: Reasonably Certain

Ruffe and Tubenose Goby (from GLB to MRB)

There is uncertainty regarding the suitability of the aquatic habitat to sustain a population of ruffe or tubenose goby in the Upper Fox River and Portage Upstream divide wetland area. The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures, and turbid conditions. Tubenose gobies are benthic species that consume a wide variety of invertebrates (USGS, 2011). They are often quite abundant in backwaters and lakes, and seem to prefer dense vegetation. Survival of a viable, reproducing population of ruffe and tubenose goby within the wetlands at the divide location is unlikely due to low water quality and high temperatures in summer months. These considerations were the primary basis for the low rating assigned to the probability that ruffe and tubenose goby could become established in close proximity to the basin divide at the upper Portage location.

Team Rating: **Low**
Team Certainty Rating: Reasonably Certain

Threespine Stickleback (from GLB to MRB)

As a visual predator, the sometimes turbid waters of the Upper Fox River at the divide may be unsuitable for the threespine stickleback. Survival of a viable, reproducing population of threespine stickleback within the rivers adjacent to the divide is feasible. The Upper Fox River would appear to provide sufficient habitat for colonization by this species.

Team rating: **Medium**
Team certainty rating: Reasonably Certain

4.4 Probability of ANS Spreading Across Aquatic Pathway into the New Basin

General Considerations for Assigning Probability Ratings:

> **High** - Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
>
> **Medium** - There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
>
> **Low** - There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

Asian Carp (from MRB to GLB)

During a flood event there would likely be favorable conditions for a sufficient period of time to allow carp to move through the pathway. Based on the hydraulic description, it is likely that carp would be able to pass over or under County Road O for at least the two percent recurrence interval flood event. Passage through the wetland area beyond County Road O could be somewhat problematic for carp because it appears that there is not a definite channel for the first mile (1.6 km), however, there are some ditches apparent beyond that point. At the two percent recurrence interval flood event there would be about 2,900 cfs (82 cms) of flow through the pathway, and it is likely that this would create sufficient depth to pass carp. There is only a reasonable certainty in this assessment because of the lack of information regarding the presence of defined channels in this pathway location and the length of time and depth of water during the period of inundation.

Team Rating: **High**
Team Certainty Rating: Reasonably Certain

Inland Silverside (from MRB to GLB)

The recurrence interval of inland silversides getting to the basin divide and then establishing a population at the site seems highly unlikely. The likelihood of establishment and subsequent crossing to the adjacent basin is limited by its ability to survive in northern latitudes.

Team Rating: **Low**
Team Certainty Rating: Moderately Certain

Northern Snakehead (from MRB to GLB)

If snakehead were to colonize the basin divide, it is highly likely that they would be able to successfully spread across the Portage Upstream pathway and into the Great Lakes Basin since there is likely sufficient suitable habitat within the pathway.

Team Rating: **High**
Team Certainty Rating: Reasonably Certain

Scud (from MRB to GLB)

Simply based on the species apparent ability to spread through the Illinois River, and it existence at higher latitudes in its native range, there is a high probability that it would be capable of expanding through the Fox River system downstream of this pathway location and into Lake Michigan. Due to the limited knowledge of this species' life history and its ability to colonize habitats outside its native range, there is only a moderate certainty of this rating. If the species were to

colonize areas of the Wisconsin River upstream of the pathway location, it could be carried through this divide location by flood waters, as a two percent recurrence interval flood creates a substantial flow of 2,900 cfs (82 cms). At this rate of flow, it seems likely that some individuals could pass the divide location.

Team rating: **High**
Team certainty rating: Moderately Certain

Plant ANS (from MRB to GLB)

Once a target plant ANS crosses the divide location, it is possible that it would be able to colonize waters within the Portage Upstream pathway and thus enter the Great Lakes Basin. However the uncertain ability of these species to form sustainable populations this far north of their current range would determine whether or not they were capable of spreading and colonizing beyond this area.

Team rating: **Medium**
Team certainty rating: Moderately Certain

Viral Hemorrhagic Septicemia Virus (from GLB to MRB)

This virus is capable of persisting outside of a host for several days, demonstrates a rapid reproductive cycle, and is capable of utilizing many different host species. It is highly probable that VHSv would be successful in spreading into exposed fish populations already on both sides of the wetland basin divide in the event infected fish reach the Portage Upstream pathway. Common carp and other host species have been found in smaller rivers and lakes. If infected fish or water containing viable VHSv were successful in reaching the divide during spring runoff, it is feasible the virus could pass into the Mississippi River Basin. The common carp have been found in smaller river systems and in the Mississippi River.

Team Rating: **High**
Team Certainty Rating: Reasonably Certain

Ruffe and Tubenose Goby (from GLB to MRB)

Ruffe and the tubenose goby have not been found in river systems similar to the Upper Fox River. If the fish were introduced into the divide, they may be successful in passing through the pathway into the Mississippi River Basin.

Team Rating: **Medium**
Team Certainty Rating: Reasonably Certain

Threespine Stickleback (from GLB to MRB)

If the threespine stickleback were introduced into the rivers adjacent the divide, it is highly likely that the fish would survive and pass through the Portage Upstream pathway into the Mississippi River Basin during a suitable flood event.

Team Rating: **High**
Team Certainty Rating: Reasonably Certain

5 Overall Aquatic Pathway Viability

As discussed in Sections 2.4 and 2.5, the determination of the likelihood of a viable aquatic pathway occurring at the Portage Upstream location for each ANS of concern is the product of five probability elements (Equation 5). Thus, the probability of a viable pathway for a particular ANS of concern is equal to the lowest rating determined for each of the five probability elements (Table 5 and Table 6). The overall pathway viability for transferring ANS of concern from the Mississippi River Basin to the Great Lakes Basin was equal to the highest probability of a viable pathway for each ANS of concern in Table 12. At the Portage Upstream location, all were rated “low” and thus the overall pathway viability for transferring species from the Mississippi River Basin to the Great Lakes Basin is “low”. The overall pathway viability for transferring species from the Great Lakes Basin is calculated the same way and is shown in Table 13. At the Portage Upstream location, the overall pathway viability for transferring species from the Great Lakes Basin to the Mississippi River Basin is “medium”. The last calculation is to determine the overall pathway viability for interbasin spread of ANS which is calculated by taking the highest of the overall ANS ratings for

unidirectional transfer which were calculated in Tables 12 and 13. Thus, in Table 13, the overall probability that a viable aquatic pathway exists at the Portage Downstream pathway is “medium”. However, caution should be exercised with this rating; VHSv is a very unique species that, because of its life history and persistence, makes it highly susceptible to transfer. This rating is identified only for transfer from the Great Lakes Basin to the Mississippi River Basin. Given its unique life history characteristics, this species is also highly likely to be transported across the basin divide by anthropogenic means. However, this did not factor into the rating for this report. Recreational fisherman and boat users can easily move this species accidentally between water bodies of both basins. While this pathway assessment did not address this likelihood, it is possible that this probability for human transfer across the divide is substantially greater than the transfer of VHSv at the divide location by natural aquatic means.

Table 12. Summary of individual probability elements and overall pathway viability (Mississippi River Basin to Great Lakes Basin). Certainty ratings for each element are in parentheses.

			Form 1 P_0	Form 2 P_1	Form 3 P_{2a}	Form 4 P_{2b}	Form 5 P_{2c}	$P_{viable\ pathway}$
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists? (Sect. 3.6)**	**Within Either Basin? (Sect. 4.1)**	**Survive Independent Transit to Pathway? (Sect. 4.2.1)**	**Establish at or Near Pathway? (Sect. 4.3)**	**Cross Path-way into New Basin? (Sect. 4.4)**	**Aquatic Pathway Viability Rating**
fish	Asian Carp, silver carp, bighead carp, black carp	swimmer	M (VC)	M (RC)	L (RC)	M (RC)	H (RC)	L
fish	inland silverside	swimmer		M (RC)	L (RC)	L (RC)	L (MC)	L
fish	northern snakehead	swimmer		M (RC)	L (RC)	M (RC)	H (RC)	L
crustacean	scud	ballast water		M (MC)	L (MC)	M (MC)	H (MC)	L
plant	dotted duckweed, marsh dewflower Cuban bulrush	rec boats and trailers		M (RU)	L (RC)	M (RC)	M (MC)	L
Overall Pathway Viability for Spread of ANS from Mississippi River Basin to Great Lakes Basin								**L**

Although the rating from the Mississippi River Basin to the Great Lakes Basin is low, there is a much higher probability of ANS passage from the Mississippi River Basin to the Great Lakes Basin if ANS ever become established in the Wisconsin River or its tributaries upstream of the Prairie du Sac Dam.

Table 13. Summary of individual probability elements and overall pathway viability rating (Great Lakes Basin to Mississippi River Basin). Certainty ratings for each element are in parentheses.

			Form 1 P_0	Form 2 P_1	Form 3 P_{2a}	Form 4 P_{2b}	Form 5 P_{2c}	$P_{viable\ pathway}$
Group	**Common Name**	**Mode of Dispersal**	**Pathway Exists? (Sect. 3.6)**	**Within Either Basin? (Sect. 4.1)**	**Survive Independent Transit to Pathway? (Sect. 4.2.1)**	**Establish at or Near Pathway? (Sect. 4.3)**	**Cross Path-way into New Basin? (Sect. 4.4)**	**Aquatic Pathway Viability Rating**
fish	threespine stickleback	swimmer	M (VC)	M (RC)	L (RC)	M (RC)	H (RC)	L
fish	Benthic fish ruffe, tubenose goby	swimmer		M (RC)	L (RC)	L (RC)	M (RC)	L
virus	viral hemorrhagic septicemia	pathogen		M (RC)	M (RC)	M (RC)	H (RC)	M
Overall Pathway Viability for Spread of ANS from Mississippi River Basin to Great Lakes Basin								**M**

6 Conclusions

An aquatic pathway exists at the Portage Upstream location during flood events that exceed a 10 percent recurrence interval, and there is a possibility that VHSv could utilize this pathway to transfer from the Great Lakes Basin into the Mississippi River Basin. The ANS of concern for Portage Upstream from the Mississippi River Basin would not be able to reach the pathway because of downstream obstructions, and the only ANS of concern that could reach the pathway from the Great Lakes Basin would need to be able to self-propel or attach to species that are able to move. For this reason, and because it can infect numerous fish species, VHSv was the only species from the Great Lakes Basin to be a threat to interbasin transfer at this location. For ANS other than VHSv to arrive at the divide in numbers substantial enough to establish a population, movement to this location would likely require human facilitation or similar mechanisms. As a result, there could be an equal potential that ANS could be transported across the basin divide and into the adjacent basin at other locations along the basin divide.

6.1 Portage Upstream Problem Statements

This section uses the results of the assessment to develop a list of statements that define and frame the nature and extent of the problems associated with the potential for transfer of ANS through Portage Upstream, in either direction between the Great Lakes and Mississippi River Basins.

- The interagency team of experts evaluating the hydrology of Portage Upstream rated it as a location where there is a medium probability for the occurrence of an aquatic pathway existing between the basins, and estimated it to have a depth ranging from about a half a foot (15 cm) to about 2 feet (61 cm) across the divide location from a slightly-greater-than 10 percent annual recurrence interval event. Furthermore, significant amounts of water are conveyed for larger events (2,900 cfs (82 cms) for the two percent annual recurrence interval event).

- Unlike most pathway locations, Portage Upstream exists along a major waterway on the Mississippi River Basin side, rather than at the headwaters of both basins. This provides the means to passively-transport any ANS (i.e., plans) that can disperse within or on the water column present on the

Wisconsin River upstream of the pathway location. As a result, any ANS established at or above the pathway location on the Wisconsin River would be afforded the opportunity to cross the divide into the Great Lakes Basin during every flood event that inundates the divide.

- The primary ANS of concern for interbasin transfer from the Mississippi River Basin through Portage Upstream into the Great Lakes Basin are fish. An interagency team that conducted the biological ratings characterized the likelihood of ANS transfer from the Mississippi River Basin through Portage Upstream into Great Lakes as medium. The three species of Asian carp are prolific swimmers and are of most concern. The northern snakehead is not as prolific a swimmer, so it is not expected to be a near-term threat. However, its affinity for ditch and wetland types of habitats and its amphibious traits make it a species with a higher likelihood of being able to establish a population and spread across the basin divide if it reaches Portage Upstream. The inland silverside has a questionable ability to colonize habitats at this latitude.

- The primary ANS of concern for interbasin transfer from the Great Lakes Basin through Portage Upstream into the Mississippi River Basin are: VHSv, a pathogen; and the threespine stickleback, ruffe, and tubenose goby; all small fish. An interagency team that evaluated the hydrology and conducted the biological characterizations rated the likelihood of ANS transfer from the Great Lakes Basin through the Portage Upstream pathway into the Mississippi River Basin as medium.

- Invertebrates and plants are also ANS of concern for interbasin transfer from the Mississippi River Basin through Portage Upstream and into the Great Lakes Basin. The team rating for the transfer of these groups of ANS is low, primarily due to the fact that these ANS do not yet occur on the Wisconsin River at, or upstream of this pathway location. Should any of these ANS become established there, the rating would likely increase.

- A contributing factor to the level of uncertainty in the hydraulic model estimates for the frequency, duration and magnitude (width, depth and flow velocity) of the intermittent aquatic pathway spanning the divide at this location is the variation in hydraulic parameters used to determine flood elevations, and the lack of detailed ground surveys and stream gage data at the basin divide. In addition, further analysis is required to determine why the 2010 flood, which had the eighth highest discharge on record, resulted in the highest recorded stage at Portage. While more data is available at Portage than at most sites, additional and better information would be needed to support any design and possible future construction of any structural measure(s) to prevent ANS transfer through this location.

- There was uncertainty associated with biological ratings due to a variety of unknowns and uncertainties regarding the location and distribution of the large array of ANS that have been introduced to the waters of the U. S., as well as the life history requirements of each of these ANS and the suitability of the habitat within the waterways between the current nearest locations of the ANS and Portage Upstream.

- There are other ways that human beings could facilitate ANS bypassing the Portage Upstream and transferring between the basins, including, but not limited to: collection of bait in one basin and release in the adjacent basin; ANS adhering to recreational boats in one basin and then being released when the vessel is placed in a water body in the adjacent basin; release of imported aquaria fish and other exotic species; etc.

6.2 Portage Upstream Opportunity Statements

While it is not the purpose of this assessment to produce and evaluate an exhaustive list of potential actions to prevent ANS transfer at this location, some opportunities were still identified that, if implemented, could prevent or reduce the probability of ANS spread between the basins at the Portage Upstream site. The following list of opportunities is not specific to the USACE,

but incorporates a wide range of possible applicable authorities, capabilities, and jurisdictions at the Federal, state, and local levels. These are as follows:

- Structural solutions could provide the highest level of confidence in preventing interbasin transfer of ANS through Portage Upstream from either direction provided adverse flood impacts can be avoided. The interagency team has tentatively identified the following range of potential structural measures to prevent ANS spread through Portage Upstream.
    - Raise the Portage Levee and permanently close culverts.
    - Construct one or more impermeable or permeable barrier(s) or floodwalls.
- There are other broad categories of technology for potential active measures that may or may not require a structure to prevent ANS transfer at this locations, such as:
    - Chemical deterrents in order to reduce habitat suitability at or near the pathway, or on connecting streams. Biological control measures that prevent ANS reproduction or prevent the ability of ANS to establish a sustainable population in the vicinity of the pathway or on connecting streams.
    - Physical removal of ANS at their current locations.

In addition to the above opportunities for Portage Upstream, other non-structural opportunities that may prevent the spread of ANS were also considered, many of which are beyond the jurisdiction of the USACE to implement but that might be implementable by other governmental and non-governmental organizations. These include, but are not limited to, the following:

- New or modified regulations or ordinances prohibiting the establishment of drainage ways that connect the Mississippi River tributaries with tributaries of Lake Michigan (e.g., ditch construction, culvert installation)
- Explore and support measures to reduce the potential source populations of certain ANS downstream of the pathway:
    - Increase commercial and recreational harvest, specifically bighead and silver carp
    - Implement measures to interfere with successful reproduction of ANS
    - Introduce biological controls such as diseases specific to particular ANS
- Public education near the pathway and at downstream locations to:
    - Prevent bait bucket transfers of ANS
    - Prevent transfer via boating and recreational equipment
    - Prevent transfer due to religious or cultural ceremonies
    - Identify and report the observation and collection of ANS to the appropriate authorities
- Site-specific elevation surveys, and hydrologic and hydraulic investigations to better correlate precipitation events to surface flows in order to gain an improved understanding of the depth and location of surface water at different flood events.
- Take ANS transfer potential into account for proposed water resource projects (e.g., ecosystem restoration, dam removal, stream restoration, water management).
- Where possible, maintain pristine habitats as whole, intact ecosystems to help prevent any ANS establishment at or near the basin divide;
- Support research on the biology of ANS so risk of transfer can be better understood.
    - Life history
    - Habitat requirements

    - History of invasiveness

- Improve and increase field sampling and monitoring for the presence of ANS to support better informed water resource management decisions within the state and region:

    - Develop integrated ANS sampling and analysis plan utilizing eDNA and conventional biological sampling events at times when ANS would be expected to be present in the area, such as during flood events.

    - Target, encourage, and train recreational fishermen, boaters and other direct users of the surface waters of the state of Wisconsin to identify, report, collect and deliver ANS to the appropriate agencies.

    - Integrated ANS monitoring focusing on the Wisconsin River downstream of the Prairie du Sac Dam would improve the effectiveness of fish passage sorting that may occur if fish passage is installed at this location by alerting those sorting fish when any undesirable species might soon be encountered.

- Prevent introductions of additional ANS.

    - Improve regulations for bilge releases

    - Improve regulations on the pet industry

    - Impose regulations on the live bait industry

    - Improve regulations on the aquaculture industry

None of the opportunities identified above are exclusive of the others. In fact, any single structural measure to prevent ANS transfer through Portage Upstream would likely benefit from corresponding development and implementation of one or more of the other types of non-structural opportunities identified. The results of this assessment may also aid in the implementation of, and future updates to, the Wisconsin ANS) comprehensive management plan.

7 References

Angradi, Ted R., D.W. Bolgrien, T. M. Jicha, M.S. Pearson, D.L. Taylor, B.H. Hill. (2009), Multispatial-scale variation in benthic and snag-surface macroinvertebrate assemblages in mid-continent US great rivers. Journal of the North American Benthological Society 28(1):122-141.

Aquatic Nuisance Species Task Force (ANSTF). (1996). Generic Nonindigineous Aquatic Organisms Risk Analysis Review Process for Estimating Risk Associated with the Introduction of Nonindigineous Aquatic Organisms and How to Manage for that Risk. Report to the Aquatic Nuisance Species Task Force. Risk Assessment and Management Committee, Aquatic Nuisance Species Task Force (October 21, 1996).

Bason, C.W. Effects of beaver impoundments on stream water quality and floodplain vegetation in the inner coastal plain of North Carolina. (Thesis Under the direction of Dr. Mark M. Brinson). Department of Biology, October 2004.

Bengtson, D.A. (1982). Resource partitioning by *Menidia menidia* (L.) and *Menidia beryllina* (Cope) in two Rhode Island estuaries. Ph. D. dissertation. University of Rhode Island, Kingston, RI

Bowen, A.K. and M.A. Goehle, (2011). Surveillance for ruffe in the Great Lakes, 2011. http://www.fws.gov/midwest/alpena/documents/2011-GL-Ruffe-Report.pdf

Bryson, C.T., V.L. Maddox, R. Carter. (2008). Spread of Cuban Club-rush (*Oxycaryum cubense*) in the Southeastern United States. Invasive Plant Science and Management 1(3):326-329.

Christy, J.A. (1994). Noteworthy collections, Washington. Madrono 41:332.

Coulter, Alison and Reuben R. Goforth. (2012). An assessment of silver and bighead carp (Hypopthalmichthys spp.) movements and spawning activities in the Wabash River Watershed, Indiana – Phase I Annual Report. Department of Forestry and Natural Resources, Purdue University, Indiana.

Courtenay, Jr., W.R., and J. D. Williams. (2004). Snakeheads (Pisces, Channidae)— A Biological Synopsis and Risk Assessment. USGS Circular 1251.

Dong, S., and Li, D. (1994). Comparative studies of the feeding selectivity of silver carp, *Hypophthalmichthys molitrix*, and bighead carp, *Aristichthys nobilis*. Journal of Fish Biology 44:621-626.

Dunn, C.P. and R.R. Sharitz. (1990a). The History of Murdannia keisak (Commelinaceae) in the Southeastern United States. Castanea 55(2): 122-129.

Dunn, C.P. and R.R. Sharitz. (1990b). The Relationship of Light and Plant Geometry to Self-thinning of an Aquatic Annual Herb, Murdannia keisak (Commelinaceae). New Phytologist 115: 559-565.

Elston, R., and B. Bachen. (1976). Diel feeding cycle and some effects of light on feeding intensity of the Mississippi silverside (*Menidia audens*) in Clear Lake, California. Transactions of the American Fisheries Society 105:84-88.

Fishbase. (2011). Froese, R. and D. Pauly. Editors. World Wide Web electronic publication: www.fishbase.org.

Fuller, P. & L. Nico. (2012a). Menidia beryllina. USGS Nonindigenous Aquatic Species Database, Gainsville, FL. http://nas.er.usgs.gov/queries/SpecimenViewer.aspx?SpecimenID=267927

Global Invasive Species Database. Accessed May 24, 2012: http://www.issg.org/database/species/ecology.asp?si=544&fr=1&sts=sss&lang=EN.

Gorbach, E. I. and Krykhtin, M. L. (1980). Maturation rate of the white amur *Ctenopharyngodon idella* and silver carp *Hypophthalmichthys molitrix* in the Amur River. Journal of Ichthyology 21(4): 835–843.

Gray, J. A. B., and A. C. G. Best. (1989). Patterns of excitation of the lateral line of the ruffe. Journal of the Marine Biological Association of the United Kingdom 69:289-306.

Grigorovich, I.A., T.R. Angradi, E.B. Emery and M.S. Wooten. (2008). Invasion of the Upper Mississippi River system by saltwater amphipods. Fundamental and Applied LimnologyArchiv für Hydrobiologie 173/1:67–77.

Hildebrand, S.F. (1922). Notes on habits and development of eggs and larvae of the silversides *Menidia menidia* and *Menidia beryllina*. Bulletin of the U.S. Bureau of Fisheries, vol.38, pp.113-120.

Hillman, W.S. (1961). The Lemnaceae, or Duckweeds: A Review of the Descriptive and Experimental Literature. The Botanical Review, vol.27(2), pp.221-287

Hubbs, C., Sharp, H. B. and Schneider, J. F. (1971). Developmental rates of *Menidia audens* with notes on salt tolerance. Transactions of the American Fisheries Society, 100:603-610.

Hudson, P. L. and C. A. Bowen II. (2002). First record of *Neoergasilus japonicus* (Poecilostomatoida: Ergasilidae), a parasitic copepod new to the Laurentian Great Lakes. Journal of Parasitology 88(4):657-663.

ISSG. 2006. Global Invasive Species Database - Landoltia punctata. http://www.issg.org/database/species/ecology.asp?si=1018&fr=1&sts=

Jacono, C.C. (2002). United States Geological Survey Nonindigenous Aquatic Species: *Landoltia punctata* = *Spirodela punctata*. http://nas.er.usgs.gov/taxgroup/plants/docs/la_punct.html

Jennings, D.P. (1988). Bighead carp (*Hypophthalmichthys nobilis*): a biological synopsis. U.S. Fish and Wildlife Service, Washington, DC. U.S. Fish and Wildlife Service Biological Report 88(29):1-47.

Jirasek, J., Hampl, A. and Sirotek, D. (1981). Growth morphology of the filtering apparatus of silver carp (*Hypophthalmichthys molitrix*). Gross anatomy state. Aquaculture 26:41-48.

Kipp, Rebekah M. and A. Ricciardi. (2011). Novirhabdovirus sp.. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=2656RevisionDate: 4/19/2010

Laird, C.S. & L.M. Page. (1996). Non-native fishes inhabiting the streams and lakes of Illinois. Illinois Natural History Survey Bulletin, vol.35(1), pp.1-51

Landolt, E. (Ed.). (1986). The family of Lemnaceae - a monographic study. Vol 1. In: Biosystematic Investigations in the Family of Duckweeds (Lemnaceae). Geobotanischen Institutes der Eidgenössischen Technischen Hochschule, Stiftung Rubel No. 71. Zürich, Switzerland. 638 pp

Lembi, C.A. (2009). Aquatic plant management control of duckweed and watermeal. Purdue University. http://www.extension.purdue.edu/extmedia/APM/APM-2-W.pdf

NatureServe. (2010). NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Accessed: July 18, 2011. http://www.natureserve.org/explorer

Nico, L.G., Williams, J.D. and Jelks, H.L. (2005). Black Carp: biological synopsis and risk assessment of an introduced fish. American Fisheries Society, Special Publication 32. Bethesda, Maryland.

Nico, L.G. and Jelks, H.L. (2011). The Black Carp in North America: An Update. American Fisheries Society Symposium 74: 89-104. Bethesda, Maryland.

NID. (2010). U.S. Army Corps of Engineers, 2010 National Inventory of Dams: http://nid.usace.army.mil.

NOAA. (2011). Great Lakes Nonindiginous Aquatic Species Information System (GLANSIS). National Oceanic and Atmospheric Administration. http://www.glerl.noaa.gov/res/Programs/glansis/watchlist.html

Page, L.M. & B.M. Burr. (1991). A field guide to freshwater fishes of North America North of

Mexico. The Peterson Field Guide Series. Houghton Mifflin Harcourt. Boston, MA. 688 pp.

Pennsylvania Sea Grant Fact Sheet. (Not Dated). Accessed from website on May 21, 2012: http://seagrant.psu.edu/publications/factsheets/VHS2011reduced.pdf

Richards, K. R. (1977). Evaluation of the Mississippi silversides as a forage fish in Colorado. (Master's thesis). Colorado State University, Fort Collins.

Skall, H.F., N. J. Olesen, and S Mellergaard. (2005). Viral haemorrhagic septicaemia virus in marine fish and its implications for fish farming – a review. Journal of Fish Diseases 28: 509–529.

Stoeckel, J. N. and Heidinger, R. C. (1988). Overwintering of the Inland Silverside in Southern Illinois. North American Journal of Fisheries Management, 8(1), 127-131.

Swearingen, J., B. Slattery, K. Reshetiloff, and S. Zwicker. 2010. Plant Invaders of Mid-Atlantic Natural Areas, 4th ed. National Park Service and U.S. Fish and Wildlife Service. Washington, DC. 168pp.

USACE. (2010). Great Lakes and Mississippi River Interbasin Study Other Pathways Preliminary Risk Characterization. Great Lakes and Ohio River Division. November 9, 2010.

USACE. (2011a). GLMRIS Focus Area 2 Study Plan. Great Lakes and Ohio River Division.

USACE. (2011b). Non-Native Species of Concern and Dispersal Risk for the Great Lakes and Mississippi River Interbasin Study

USFWS. (1996). Ruffe control plan. Submitted to the Aquatic Nuisance Species Task Force by the Ruffe Control Committee. Available at: http://www.fws.gov/midwest/ashland/ruf_cont.html

USFWS. (2002). Black Carp Invasive Species Program Fact sheet. United States Fish and Wildlife Service. Retrieved from: http://www.fws.gov/southeast/hotissues/Black_Carp_FS.pdf

USGS. (2011). Nonindigenous Aquatic Species (NAS) website. http://nas.er.usgs.gov. Accessed 11 Ocotober 2011.

USGS. (2012). Nonindigenous Aquatic Species (NAS) website, ruffe. http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=7 Accessed 13 June 2012.

Verigin, B.V., A.P. Makeyeva, and M.I. Zaki Mokhamed. (1978). Natural spawning of the silver carp (*Hypophthalmichthys nobilis*), the bighead carp (*Aristichthys nobilis*), and the grass carp (*Ctenopharyngodon idella*) in the Syr-Dar'ya River. Journal of Ichthyology 18(1):143-146.

WDNR. (2012a). VHS Distribution in Wisconsin. Wisconsin Department of Natural Resources. Website accessed April 25, 2012: http://dnr.wi.gov/fish/vhs/vhs_widistribution.html

WDNR. (2012b). VHS 101 Fact Sheet. Wisconsin Department of Natural Resources. Website accessed April 10, 2012: http://dnr.wi.gov/fish/vhs/vhsfacts.html#3a

Weinstein, M.P. (1986). Habitat suitability index models: inland silverside. U.S. Fish and Wildlife Service Biol. Rep. 82(10.120). 25 pp.

Williamson, C. J. and Garvey, J. E. (2005). Growth, fecundity, and diets of newly established silver carp in the middle Mississippi River. Transactions of the American Fisheries Society 134: 1423–1430.

Wootton, R.J. (1976). The Biology of the Stickleback. Academic Press. London.

WRDA. (2007). Water Resources Development Act of 2007 [Section 3061(d): P.L. 110-114; amends Section 345: P.L. 108-335; 118 Stat. 1352].

Ysebaert, T., L. DeNeve, P. Meire. (2000). The subtidal macronemthos in the mesohaline part of the Schelde Estuary (Belgium): influenenced by man? Journal of te Marine Biological Association of te United Kingdom 80:587-597.

Appendix A

Evaluation Forms for each ANS of Concern Selected for the Portage Upstream Pathway

Portage Upstream Report

November, 2012

Portage Upstream Report

November, 2012

Portage Upstream, Columbia County, WI - Asian Carp

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, Detroit - Hydraulic Engineer	Medium	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**RC**	**Medium**	**RC**

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: Interbasin flows at Portage upstream (Lewiston Levee) are well documented as part of the Portage FRM project and FIS update. In Mike Lesher's 2010 assessment of potential hydraulic connections he states that water must flow over a low point in County Road O, through culverts/bridges under the Soo Line RR tracks and Highway 16 or over the Soo Line RR tracks and Highway 16, then to Big Slough, to Neenah Creek, and finally to the Fox River. For a 10% chance flood there is no connection, but again from Mike Lesher's assessment, a connection exists for slightly greater than the 10% chance flood. Significant amounts of water are conveyed at this connection for larger flood events (e.g. 2900 cfs for the 2% chance flood). Based on an email from Robert Wakeman (WDNR) to Mike Saffran (USACE) on 8/11/2010, three connection points are identified for Portage upstream. These include two culverts under County Road O and a low point in County Road O. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins with a floodway shown from the Wisconsin River to Big Slough and Neenah Creek. During the site visit on 06-June-2011, no flow was occuring and it wasn't clear where the connection points were. Grassy and herbacious vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches from County Road O northeast to highway 16 and then a continuous channel (Neenah Creek) starting on the south side of highway 127 that continues to the Fox River.

Portage Upstream, Columbia County, WI - Asian Carp

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**RC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	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: Silver carp and bighead carp are established in the middle and lower Mississippi River Basin. The nearest known reproducing populations are found at the Quad Cites, over 100 miles (161 km) south of the Wisconsin River. Single individuals have been collected from the Mississippi River at a number of places upstream of this, but there is no evidence of successful reproduction or self-sustaining populations. Two bighead carp have been collected in the Wisconsin River below the Prairie du Sac Dam in 2011 (USGS, 2011). Silver carp have been collected in the Mississippi River well upstream of the mouth of the Wisconsin River and would be likely to able to reach the Prairie du Sac dam as evidenced by the collection of bighead carp there. However, the Prairie du Sac Dam is a complete barrier to Asian carp upstream movement and prevents them from reaching the Portage area. Even when upstream fish passage is installed at PdS Dam, estimated to be constructed in 2013 or 2014, the design and operation of the facility (fish elevator; all fish in elevator identified and sorted before being allowed to move over the dam) will prevent upstream movement of Asian carp. Black carp likely have a more limited distribution and are less likely to reach the PdS Dam in the near-term. Barring deliberate or unintentional movement of Asian carp by human transport, it is unlikely that Asian carp will reach Portage within the next 20 years.

Portage Upstream, Columbia County, WI - Asian Carp

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul - Biologist	Low	RC	Medium	RC
	USACE, Detroit - Biologist	Low	RC	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RC	Medium	RC
	Team Ratings	**Low**	**RC**	**Medium**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	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: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. Passage of Asian carp upstream of the Prairie du Sac (PdS) dam is unlikely because it is reported to be a complete fish barrier by the WDNR, presumably due to it high hydraulic head (39 feet) and lack of a fishway. However, a fishway at this dam is planned for construction (completion estimated for 2013 or 2014), but the fishway would be a fish elevator used to only provide passage for desirable species. Assuming it is operated to only pass desirable species, this would nearly eliminate the potential for Asian carp to move upstream of the PdS dam. However, operation of such a fishway would be subject to human error, which is why a reasonable certainty (RC) was applied to this rating.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. The probability of Asian carp arriving at the pathway through other means is higher due to the large area upstream of the PdS dam and the Portage site, coupled with the high recreational use of the Wisconsin River and its flowages there. This could result in bait bucket transfers of juvenile Asian carp, though the chance of such a transfer seems small because carp grow quickly and would likely be mistaken for bait only when very young. A greater consideration in the rating is the fact that there is a large and accessible area of river and flowages upstream of the PdS dam, which would increase the potential for intentional or accidental releases of Asian carp. Those flowages would provide suitable habitat for the fish and any established population of Asian carp there would likely have continuous access to this pathway location because most dams do not substantially inhibit the downstream migration of fish. Asian carp are a specifically prohibited species by name in WI.

Portage Upstream, Columbia County, WI - Asian Carp

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty
	USACE, St. Paul - Biologist	Medium	RC
	USACE, Detroit - Biologist	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	High	RC
	Team Ratings	**Medium**	**MC**

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	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: Silver and bighead carp are fast growing species that are capable of surviving a wide range of water temperatures and reproducing quickly, provided that suitable habitat is available. Life history and habitat requirements generally include diverse needs for current areas, backwater habitats, deep overwintering holes, and other habitat types needed for survival (Nico, et al., 2005). Silver and bighead carp require sufficient flow to keep fertilized eggs suspended for successful reproduction (Gorbach and Krykhtin, 1980). It is unlikely that Asian carp would be able to survive for long periods of time on the pathway because it is a shallow wetland habitat that would likely freeze-out during winter, or reach high temperatures with low oxygen levels during the summer. However, it seems more likely that these species would be able to survive on the Wisconsin River in proximity to the pathway, as it would likely provide suitable habitat for adults and may even provide habitat for spawning and rearing in some reaches.

Portage Upstream, Columbia County, WI - Asian Carp

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	High	RC		
	USACE, Detroit - Biologist	High	RC		
	Wisconsin DNR, Fisheries Research Scientist	High	RC		
	Team Ratings	**High**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	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: During a flood event there would likely be favorable conditions for a sufficient period of time to allow carp to move through the pathway. Based on the hydraulic description, it is likely that carp would be able to pass over or under County Road O for at least the two percent recurrence interval flood event. Passage through the wetland area beyond County Road O could be somewhat problematic for carp because it appears that there is not a definite channel for the first mile (1.6 km), however, there are some ditches apparent beyond that point. At the two percent recurrence interval flood event there would be about 2,900 cfs (82 cms) of flow through the pathway, and it is likely that this would create sufficient depth to pass carp. There is only a reasonable certainty in this assessment because of the lack of information regarding the presence of defined channels in this pathway location and the length of time and depth of water during the period of inundation.

Portage Upstream, Columbia County, WI - Inland Silverside (*Menidia beryllina*)

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, Detroit - Hydraulic Engineer	Medium	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**RC**	**Medium**	**RC**

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: Interbasin flows at Portage upstream (Lewiston Levee) are well documented as part of the Portage FRM project and FIS update. In Mike Lesher's 2010 assessment of potential hydraulic connections he states that water must flow over a low point in County Road O, through culverts/bridges under the Soo Line RR tracks and Highway 16 or over the Soo Line RR tracks and Highway 16, then to Big Slough, to Neenah Creek, and finally to the Fox River. For a 10% chance flood there is no connection, but again from Mike Lesher's assessment, a connection exists for slightly greater than the 10% chance flood. Significant amounts of water are conveyed at this connection for larger flood events (e.g. 2900 cfs for the 2% chance flood). Based on an email from Robert Wakeman (WDNR) to Mike Saffran (USACE) on 8/11/2010, three connection points are identified for Portage upstream. These include two culverts under County Road O and a low point in County Road O. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins with a floodway shown from the Wisconsin River to Big Slough and Neenah Creek. During the site visit on 06-June-2011, no flow was occuring and it wasn't clear where the connection points were. Grassy and herbacious vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches from County Road O northeast to highway 16 and then a continuous channel (Neenah Creek) starting on the south side of highway 127 that continues to the Fox River.

Portage Upstream, Columbia County, WI - Inland Silverside (*Menidia beryllina*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**RC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	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: Inland silversides have not been collected in the Wisconsin River. Recently, its most northern know occurrence in the Mississippi River Basin is on the Kankakee River in Will County Illinois, where they were collected in 1996 (USGS, 2011). The species was stocked in Turtle Lake in Ramsey County, Minnesota in 1950, but that population failed. It appears that the majority of the locations in which this species is collected outside of its native range is a result of stocking, and the species is not being collected far from the initial stocking area. There is no evidence that the species has expanded beyond these areas and it is unlikely it would reach the pathway on its own within the next 20 years.

Portage Upstream, Columbia County, WI - Inland Silverside (*Menidia beryllina*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul - Biologist	Low	RC	Low	RC
	USACE, Detroit - Biologist	Low	RC	Low	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	VC	Low	RC
	Team Ratings	**Low**	**RC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	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: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. The ability of this species to reach the divide at Portage is low for at three reasons. First, it has apparently been unable to successfully colonize areas in the upper MRB beyond where it has been stocked, and stocking had failed at Turtle Lake in Minnesota. Second, as a small fish it is unlikely to be able to move great distances upstream to the Prairie du Sac dam. Third, the PdS dam would likely serve as an effective barrier to upstream travel.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. The likelihood that the species reaches the divide through other means such as bait bucket transfer was also rated as low due to its absence in WI, but the certainty of this rating is lower because bait bucket transfer would still be possible due to the high recreational use of the Wisconsin River, even though this species is prohibited under WI law (NR 40.02(17)). Bait bucket transfers are also extremely unlikely, as silversides are very fragile and can only be transported successfully with specialized equipment and will not survive more than a few minutes in a typical bait bucket (WDNR).

Portage Upstream, Columbia County, WI - Inland Silverside (*Menidia beryllina*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Low	RC		
	USACE, Detroit - Biologist	Low	RC		
	Wisconsin DNR, Fisheries Research Scientist	Low	RC		
	Team Ratings	**Low**	**RC**		

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	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: As a size-selective planktivore, the inland silverside relies primarily on sight for feeding, which could be limited within and around the wetlands at the divide (Elston and Bachen, 1976). The divide location would likely be unable to support the species because of winter freeze-out and/or low dissolved oxygen levels in the summer. Hubbs, et al. (1971) inferred that the native inland range for the inland silverside does not extend beyond the confluence of the Ohio and Mississippi Rivers because it cannot withstand winters farther north. However, Richards (1977) showed that the inland silverside can survive for at least two weeks at 34.7o F (1.5o C). Stoeckel and Heidinger (1988) demonstrated that inland silversides can be maintained over winter in aquaculture systems at temperatures above 59o F (15o C), when they were fed a prepared diet. They also demonstrated that inland silversides have a high mortality during extended periods of cold during the winter in unheated ponds and reservoirs. Currently there are no records of established populations at this latitude. The lack of quality habitat for this species at these basin connections would make it difficult for this species to colonize and become established in this location. The Wisconsin River at this location may have suitable habitat, but the site may be too far north for the species to survive, which is supported by the lack of successful populations being reported this far north, even after intentional stocking. It is possible that individuals could pass through the pathway during flood events, but this would be less likely than with larger more mobile fish species.

Portage Upstream, Columbia County, WI - Inland Silverside (*Menidia beryllina*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Low	MC		
	USACE, Detroit - Biologist	Low	MC		
	Wisconsin DNR, Fisheries Research Scientist	Low	RC		
	Team Ratings	**Low**	**MC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	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: The chance of inland silversides getting to the basin divide and then establishing a population at the site seems highly unlikely. The likelihood of establishment and subsequent crossing to the adjacent basin is limited by its ability to survive in northern latitudes.

Portage Upstream, Columbia County, WI - Northern Snakehead (*Channa argus*)

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, Detroit - Hydraulic Engineer	Medium	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**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: Interbasin flows at Portage upstream (Lewiston Levee) are well documented as part of the Portage FRM project and FIS update. In Mike Lesher's 2010 assessment of potential hydraulic connections he states that water must flow over a low point in County Road O, through culverts/bridges under the Soo Line RR tracks and Highway 16 or over the Soo Line RR tracks and Highway 16, then to Big Slough, to Neenah Creek, and finally to the Fox River. For a 10% chance flood there is no connection, but again from Mike Lesher's assessment, a connection exists for slightly greater than the 10% chance flood. Significant amounts of water are conveyed at this connection for larger flood events (e.g. 2900 cfs for the 2% chance flood). Based on an email from Robert Wakeman (WDNR) to Mike Saffran (USACE) on 8/11/2010, three connection points are identified for Portage upstream. These include two culverts under County Road O and a low point in County Road O. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins with a floodway shown from the Wisconsin River to Big Slough and Neenah Creek. During the site visit on 06-June-2011, no flow was occuring and it wasn't clear where the connection points were. Grassy and herbacious vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches from County Road O northeast to highway 16 and then a continuous channel (Neenah Creek) starting on the south side of highway 127 that continues to the Fox River.

Portage Upstream, Columbia County, WI - Northern Snakehead (*Channa argus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	VC		
	Team Rating	**Medium**	**RC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	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: The closest established population of northern snakeheads is in Lee County, Arkansas. While this is in the Mississippi River Watershed, this population does not seem to be spreading at a high rate at this time (USGS, 2011). A single specimen of giant snakehead (Channa micropeltes) was collected in the Rock River by the WDNR (a watershed not directly connected with the Portage Upstream pathway). This specimen was unintentionally released. However, the species is considered to be tropical to sub-tropical and not able to survive winter temperatures encountered in the Rock River (Courtenay, Jr. and Williams, 2004).

Portage Upstream, Columbia County, WI - Northern Snakehead (*Channa argus*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul - Biologist	Low	RC	Medium	MC
	USACE, Detroit - Biologist	Low	RC	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	VC	Low/Medium	MC
	Team Ratings	**Low**	**RC**	**Medium**	**MC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	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: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. If the Arkansas population does begin to expand into and up the Mississippi River, there are many barriers to migration including dams on the river and its tributaries. Habitat preferred by northern snakeheads includes stagnant, shallow ponds or swamps with mud substrate and aquatic vegetation; slow muddy streams (Courtenay and Williams, 2004). The main stem of much of the Mississippi River may not provide adequate habitat to this species to maintain a viable population to attempt a migration towards the Great Lakes. Furthermore, this species has not demonstrated a tendency to migrate over great distances.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. It is more likely that the species would be transported to the pathway location by other means. Bait bucket transfer seems unlikely due to the snakehead's size and physical appearance (it does not look like a bait species). However, there is a reasonable possibility that the species would be released into waters intentionally, as has been the case in other introductions. There is a large area of the Wisconsin River and its flowages upstream of the pathway location easily accessed by the public. The certainty of such a release is only moderate, because numerous efforts have been made to prevent such things from happening including the fact that the species is prohibited under Wisconsin law (NR 40.02(17)).

Portage Upstream, Columbia County, WI - Northern Snakehead (*Channa argus*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Ratings	**Medium**	**RC**		

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	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: The northern snakehead's native range (latitude 24-53º N) and temperature tolerance 32º F-86º F (0-30º C) indicates a species that, if introduced, could establish populations throughout most of the contiguous United States (Courtenay, Jr. and Williams, 2004). Northern snakeheads are naturally aggressive predators that could easily acclimate to the conditions in and around the wetland divide as long as there is an ample food supply. They prefer shallow ponds and marshes with aquatic vegetation, which is similar to the aquatic habitat at the wetland divide. The snakehead's preference for shallow aquatic and wetland habitats, coupled with its ability to breathe air, make it more possible for this species to colonize the deeper wetlands in the divide location. It still may succumb to winter freeze-out, but it does have the ability to survive under the ice. Food may be a limiting factor for the establishment of a population here. The propensity for this species to quickly move through an area such as the divide during flooding is less certain, though the species is not known for migrating long distances. This species is not known to readily move over dry land in response to declining water levels as are some species of snakehead.

Portage Upstream, Columbia County, WI - Northern Snakehead (*Channa argus*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	High	RC		
	USACE, Detroit - Biologist	High	RC		
	Wisconsin DNR, Fisheries Research Scientist	High	RC		
	Team Ratings	**High**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	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: If snakehead were to colonize the basin divide, it is highly likely that they would be able to successfully spread across the Portage Upstream pathway and into the Great Lakes Basin since there is likely sufficient suitable habitat within the pathway.

Portage Upstream, Columbia County, WI - Scud (*Apocorophium lacustre*)

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, Detroit - Hydraulic Engineer	Medium	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**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: Interbasin flows at Portage upstream (Lewiston Levee) are well documented as part of the Portage FRM project and FIS update. In Mike Lesher's 2010 assessment of potential hydraulic connections he states that water must flow over a low point in County Road O, through culverts/bridges under the Soo Line RR tracks and Highway 16 or over the Soo Line RR tracks and Highway 16, then to Big Slough, to Neenah Creek, and finally to the Fox River. For a 10% chance flood there is no connection, but again from Mike Lesher's assessment, a connection exists for slightly greater than the 10% chance flood. Significant amounts of water are conveyed at this connection for larger flood events (e.g. 2900 cfs for the 2% chance flood). Based on an email from Robert Wakeman (WDNR) to Mike Saffran (USACE) on 8/11/2010, three connection points are identified for Portage upstream. These include two culverts under County Road O and a low point in County Road O. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins with a floodway shown from the Wisconsin River to Big Slough and Neenah Creek. During the site visit on 06-June-2011, no flow was occuring and it wasn't clear where the connection points were. Grassy and herbacious vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches from County Road O northeast to highway 16 and then a continuous channel (Neenah Creek) starting on the south side of highway 127 that continues to the Fox River.

Portage Upstream, Columbia County, WI - Scud (*Apocorophium lacustre*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	MC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RU		
	Team Rating	**Medium**	**MC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	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: This is a species of scud that is native to the Atlantic coast of North America and is established in the Illinois River Basin (USGS, 2011). It does not densely populate the Mississippi River Basin, but it can be locally abundant. It was first reported in the Lower Mississippi River in 1987-1988, and then later found in the Ohio River in 1996, and it moved 714 miles (1,150 km) up the Ohio River within a year, likely due to shipping (Grigorovich, et al., 2008). It is currently unknown to exist in the Great Lakes Basin. The species is unable to move upstream significant distances under its own power, so it is unable to use the Mississippi River as a waterway to move into the Wisconsin River. For these reasons, it was determined that the species would be unlikely to reach the Portage Upstream Pathway within the next 20 years.

Portage Upstream, Columbia County, WI - Scud (*Apocorophium lacustre*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul - Biologist	Low	RC	Medium	MC
	USACE, Detroit - Biologist	Low	MC	Medium	MC
	Wisconsin DNR, Fisheries Research Scientist	Low	RU	Medium	MC
	Team Ratings	**Low**	**MC**	**Medium**	**MC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	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: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. The species is not in proximity to the pathway and is small and minimally mobile and, therefore, does not likely have the ability to migrate upstream to the pathway under its own power in the next 25 years. While upstream dispersal has been observed on the Illinois River (USACE, 2011a), it is unlikely that this species can move upstream significant distances under its own power.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. It is more likely that the species would be transported to the pathway and/or a location on the Wisconsin River upstream of the pathway through anthropogenic means than by natural means. There is a large area upstream of the pathway that is heavily utilized for recreation, and it is possible for the species to be carried from its current location to the Wisconsin River in water within recreational vessels or in bait buckets.

Portage Upstream, Columbia County, WI - Scud (*Apocorophium lacustre*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	MC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RU		
	Team Ratings	**Medium**	**MC**		

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	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: Suitable habitat includes rocky and/or sandy shoals (Angradi, 2009; Grigorovich, et al., 2008). It seems likely that, if introduced, the species would be able to colonize waters near the pathway, as it seems to have successfully established throughout the Illinois River, and the pathway location is within the latitudinal limits of it native range and it appears to be tolerant of a wide range of temperatures based on its current distribution (Ysebaert, et al., 2000). It is less certain that it would be able to colonize the wetlands at the divide location.

Portage Upstream, Columbia County, WI - Scud (*Apocorophium lacustre*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	High	MC		
	USACE, Detroit - Biologist	High	MC		
	Wisconsin DNR, Fisheries Research Scientist	High	MC		
	Team Ratings	**High**	**MC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	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: Simply based on the species apparent ability to spread through the Illinois River, and it existence at higher latitudes in its native range, there is a high probability that it would be capable of expanding through the Fox River system downstream of this pathway location and into Lake Michigan. Because of the limited knowledge of this species' life history and its ability to colonize habitats outside its native range, there is only a moderate certainty of this rating. If the species were to colonize areas of the Wisconsin River upstream of the pathway location, it could be carried through this divide location by flood waters, as a two percent recurrence interval flood passes a substantial flow (2,900 cfs or 82 cms). At such a rate of flow, it seems likely that some individuals could pass the divide location.

Portage Upstream, Columbia County, WI - ANS Plant from MRB

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, Detroit - Hydraulic Engineer	Medium	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**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: Interbasin flows at Portage upstream (Lewiston Levee) are well documented as part of the Portage FRM project and FIS update. In Mike Lesher's 2010 assessment of potential hydraulic connections he states that water must flow over a low point in County Road O, through culverts/bridges under the Soo Line RR tracks and Highway 16 or over the Soo Line RR tracks and Highway 16, then to Big Slough, to Neenah Creek, and finally to the Fox River. For a 10% chance flood there is no connection, but again from Mike Lesher's assessment, a connection exists for slightly greater than the 10% chance flood. Significant amounts of water are conveyed at this connection for larger flood events (e.g. 2900 cfs for the 2% chance flood). Based on an email from Robert Wakeman (WDNR) to Mike Saffran (USACE) on 8/11/2010, three connection points are identified for Portage upstream. These include two culverts under County Road O and a low point in County Road O. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins with a floodway shown from the Wisconsin River to Big Slough and Neenah Creek. During the site visit on 06-June-2011, no flow was occuring and it wasn't clear where the connection points were. Grassy and herbacious vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches from County Road O northeast to highway 16 and then a continuous channel (Neenah Creek) starting on the south side of highway 127 that continues to the Fox River.

Portage Upstream, Columbia County, WI - ANS Plant from MRB

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RU		
	USACE, Detroit - Biologist	Medium	RU		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**RU**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	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: Plant ANS are being evaluated for the Portage Upstream site because of its unique geographic position in the watershed in that it is not at the upper headwaters of the two drainage basins. Instead, it occurs along the Wisconsin River at point with a large upstream drainage area. This results in the potential for upstream floodwaters in the Wisconsin River Basin to flow into the Great Lakes Basin, thereby permitting any material, including plant material, to be carried to and over the divide by floodwaters. It also means that there is a large source area upstream of the divide location that can be colonized by ANS, and provide a consistent source of ANS material during floods.

Three plant species that were listed as being of concern to the Great Lakes Basin include dotted duckweed, marsh dewflower, and Cuban bulrush. Additional plant species have also been determined to be of concern by professionals in the field, but for the purpose of this assessment all are being treated collectively as nuisance plant species. Only those species found in the Mississippi River Basin but not in the Great Lakes Basin have been considered here because water from the Great Lakes Basin would not flow into the Mississippi River Basin except possibly under extremely rare occasions. None of the three listed species have been found in Wisconsin, but dotted duckweed is the species in closest proximity, having been found in Bureau County Illinois. Marsh dewflower was reported in Louisiana in the 1920's but has not spread very far up the Mississippi River (Dunn and Sharitz, 1990a). Because these plants are unable to "migrate" upstream unassisted, it is believed that they are unlikely to be found within or above this pathway location within the next 20 years without human transport. However, there is reasonable uncertainty in this rating because there is a large area potentially suitable for such plants species to establish upstream of the pathway location.

Portage Upstream, Columbia County, WI - ANS Plant from MRB

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul - Biologist	Low	RC	Medium	RC
	USACE, Detroit - Biologist	Low	RC	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RC	Medium	RC
	Team Ratings	**Low**	**RC**	**Medium**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	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: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. As discussed above, it is highly unlikely that a plant ANS would reach the divide location without assistance in the foreseeable future.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. There seems to be a reasonable certainty that an ANS plant species could be introduced to the divide location by some other means, either natural or anthropogenic, within the next 20 years. The fact that there is a large area upstream of the divide location that could be colonized by plant ANS, and those plant colonies could then provide a continuous source of plant material to the divide location is of major importance at this site. Any of these species could be transported to or upstream of the divide location through recreational boats and trailers, and there are numerous instances such introductions. Education is an important factor in reducing human transport, and this means of introduction is not hampered by watershed divides.

Dotted duckweed is a small, inconspicuous duckweed species which could relatively easily be unintentionally transported by boats/trailers traveling into WI from surrounding states. It could also be spread through the migration/movement of waterfowl or small mammals (ISSG, 2006; Jacono, 2002). Marsh dewflower and Cuban bulrush also produce both seeds and vegetative fragments which could be transported by human/animal means; however, neither species is currently reported from any states in close proximity to WI. At least one of these species, the Cuban bulrush, can also be transported in the gut of migratory birds.

Portage Upstream, Columbia County, WI - ANS Plant from MRB

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty
	USACE, St. Paul - Biologist	Medium	RC
	USACE, Detroit - Biologist	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC
	Team Ratings	**Medium**	**RC**

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	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: If a plant ANS were to become established at or above the pathway location, it would likely be able to colonize the divide location or at the very least be able to be carried through the divide location by floodwaters. The wetland habitat found at the divide location would likely be suitable for at least one, if not all, of the target plant ANS of concern for this site. At a 50-year event, there would be about 2,900 cfs (82 cms) flowing from the Wisconsin River to the Great Lakes Basin. This amount of flow would easily carry plant material into the divide location. This would especially be true for floating material such as dotted duckweed, marsh dewflower, or the floating achenes of the Cuban bulrush. However, the ability of these species to grow and overwinter in Wisconsin would play an important factor in whether they would be able to establish a sustainable population. Dotted duckweed exhibits a low winter tolerance and is unable to form turions (over-winter buds) like many of our native duckweeds (Jacono, 2002). The native and current adventive range of Cuban bulrush is tropical to sub-tropical in climate (Bryson et al., 2008), and little is known about its basic biological and ecological characteristics. Marsh dewflower is most prevalent in the southeastern United States, although some sparse populations have been reported in the temperate climates of the Pacific Northwestern U.S. (Christy, 1994), and its survival ability in Wisconsin is uncertain. Habitats of marsh dewflower include forested, emergent and shrub scrub wetlands (Bason, 2004).

Portage Upstream, Columbia County, WI - ANS Plant from MRB

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	MC		
	USACE, Detroit - Biologist	Medium	MC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Ratings	**Medium**	**MC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	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: Once a target plant ANS crosses the divide location, it is possible that it would be able to colonize waters within the Portage Upstream pathway and thus enter the Great Lakes Basin. However the uncertain ability of these species to form sustainable populations this far north of their current range would determine whether or not they were capable of spreading and colonizing beyond this area.

Portage Upstream, Columbia County, WI -Viral Hemmorhagic Septicemia virus (VHSv)

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, Detroit - Hydraulic Engineer	Medium	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**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: Interbasin flows at Portage upstream (Lewiston Levee) are well documented as part of the Portage FRM project and FIS update. In Mike Lesher's 2010 assessment of potential hydraulic connections he states that water must flow over a low point in County Road O, through culverts/bridges under the Soo Line RR tracks and Highway 16 or over the Soo Line RR tracks and Highway 16, then to Big Slough, to Neenah Creek, and finally to the Fox River. For a 10% chance flood there is no connection, but again from Mike Lesher's assessment, a connection exists for slightly greater than the 10% chance flood. Significant amounts of water are conveyed at this connection for larger flood events (e.g. 2900 cfs for the 2% chance flood). Based on an email from Robert Wakeman (WDNR) to Mike Saffran (USACE) on 8/11/2010, three connection points are identified for Portage upstream. These include two culverts under County Road O and a low point in County Road O. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins with a floodway shown from the Wisconsin River to Big Slough and Neenah Creek. During the site visit on 06-June-2011, no flow was occuring and it wasn't clear where the connection points were. Grassy and herbacious vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches from County Road O northeast to highway 16 and then a continuous channel (Neenah Creek) starting on the south side of highway 127 that continues to the Fox River.

Portage Upstream, Columbia County, WI -Viral Hemmorhagic Septicemia virus (VHSv)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**RC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	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: Viral Hemorrhagic Septicemia virus can infect a wide range of host fish causing a variety of external and internal pathology including death of the host fish (Attachment B). Variables such as host fish species and water temperature can impact the pathology of the virus. Seemingly healthy individuals that have been previously infected with VHSv can have chronic infections and be carriers of the disease (Skall et al., 2005). This virus has been reported from throughout the Great Lakes Basin including Lake Michigan and was found in Lake Winnebago in 2007, but not since (USGS, 2011).

Viral Hemorrhagic Septicemia virus has been found in many species of fish including common carp (Cyprinus carpio). The common carp is established in Lake Michigan, as well as the Fox River leading to the divide. While other host fish species are known to exist in the pathway system, the common carp was selected as the most likely host species for VHSv because of the life cycle capabilities of the common carp and the likelihood the common carp could use and survive in the pathway habitats. VHSv and a necessary host species, the common carp, are in the pathway. It should also be noted that VHSv has been found in 28 different host fish species in the Great Lakes Basin and that it can survive without a host in the water column (WDNR, 2012b).

Carp from Lake Winnebago have access to the upper Fox (although several low-head dams along the way provide substantial barriers), but the river is warm, and it's uncertain whether VHS could persist in the system even if infected fish swam up the Fox River from Lake Michigan.

Portage Upstream, Columbia County, WI -Viral Hemmorhagic Septicemia virus (VHSv)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul - Biologist	Medium	RC	Low	RC
	USACE, Detroit - Biologist	Medium	RC	Low	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RC	Low	RC
	Team Ratings	**Medium**	**RC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	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: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. From Lake Winnebago to the watershed divide at Portage along the Upper Fox River is approximately 100-120 miles. The Lower Fox River, connecting Lake Winnebago and Green Bay, is 39 miles long. USGS gage 04073365 on the Fox River at Princeton, Wisconsin (about 50 miles from the watershed divide) shows average river discharge ranges from 1,300 cfs in June to 550 cfs low flow in September.
VHSv has been identified in Lake Winnebago and so has the common carp, which is also present in the Fox River. Infected common carp, as a carrier of VHSv (and potentially the parasitic copepod (N. japonicus)) have not been identified within the Upper Fox River. However, the lock and dam system and dam heights on the Fox River appear to be insufficient to prevent the upstream migration of fish from Lake Winnebago that could carry VHSv, and VHSv could reach the divide location assuming it is still present in Lake Winnebago. The Rapid Croche lock and dam downstream of Lake Winnebago, is considered a block to upstream ANS migration by the WDNR. However, fish can pass at the 10 year flood event.
At flood stage, the Wisconsin River waters would cross the upstream Portage divide by sheet flow over the Lewiston Levee and County Road O traveling more than a mile across farm fields or emergent wetlands to the GLB. The lack of a direct ditch connection for flowing waters from the MRB to the GLB minimizes the probability of invasive species transfer from the GLB to the MRB during an overflow event. However, if sufficient water depths of a foot or more were maintained in the farm fields or the wetlands on both sides of the low point over County Road O for a few days during spring spawning season, common carp could possibly find a path through the flooded divide and the roadside ditches and into the MRB, thus the rating of medium. If the road or levee washed out during a large storm event, the probability of fish passage over the divide would increase. If common carp were present in the Fox River during a spring runoff event of sufficient duration, it is possible that the infected carp could transfer to the MRB and find suitable habitat to flourish. The farm and wetland divide provide the primary basis for the level of certainty rating assigned to this location for this specific ANS, represented by the common carp as the host fish for VHSv.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. There is no evidence or information to suggest the farm fields or emergent wetland at the divide are recreational areas used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this location by anthropogenic means. Further, in the unlikely event an infected carp is introduced into into the divide, the aquatic habitat is considered marginally suitable for survival of the host common carp for at least the summer during most years. While the common carp is a very tolerant fish, survival of VHSv infected carp in the pond through the late summer when water temperatures in the small water body become elevated and dissolved oxygen content diminishes is considered unlikely. Establishment of a population within the divide is considered low. These considerations were the primary basis for the assigment of a low rating to the probability ANS will survive transit to the aquatic pathway by other means and the reasonable certainty assigned to the rating.

Portage Upstream, Columbia County, WI -Viral Hemmorhagic Septicemia virus (VHSv)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Low	RC		
	Team Ratings	**Medium**	**RC**		

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	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: During spring run-off events in April/May, common carp migrate into the shallow waters of bays and river systems to spawn. Within the rivers, common carp migrate upstream to spawn in suitable habitat such as marshes and even drainage ditches and emergent wetlands with as little as or less than one foot depth of water. Common carp are strong swimmers and though they cannot jump like members of the salmon family, they can migrate upstream during moderate flow events. Survival and reproduction of common carp as a potential carrier of VHSv is considered fairly good at this location during the spring. During spring runoff, the wetland divide and connecting ditches/streams would provide the necessary habitat for occupation of any VHSv carrier/host fish species, at least temporarily. The adjacent rivers provide suitable habitat for all life stages of the common carp. The virus is capable of persisting outside of a host in the water column for at least 14 days and grows best in fish when water temperatures are 37º F - 54 º F (2.8 º C - 12.2 º C). It also demonstrates a rapid reproductive cycle and is capable of utilizing up to 28 known fish species in the Great Lakes Basin, including common carp (WDNR, 2012b). These considerations were the primary basis for the medium rating assigned to the probability that VHSv could become established in close proximity to the upper Portage divide.

Portage Upstream, Columbia County, WI -Viral Hemmorhagic Septicemia virus (VHSv)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	High	RC		
	USACE, Detroit - Biologist	High	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Ratings	**High**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	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: This virus is capable of persisting outside of a host for several days, demonstrates a rapid reproductive cycle, and is capable of utilizing many different host species. It is highly probable that VHSv would be successful in spreading into exposed fish populations already on both sides of the wetland basin divide in the event infected fish reached the Portage Downstream pathway. Common carp and other host species have been found in smaller rivers and lakes. If infected fish or water containing viable VHSv were successful in reaching the divide during spring runoff, it is feasible the virus could pass into the Mississippi River Basin. The common carp have been found in smaller river systems and in the Mississippi River.

Portage Upstream, Columbia County, WI - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

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, Detroit - Hydraulic Engineer	Medium	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**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: Interbasin flows at Portage upstream (Lewiston Levee) are well documented as part of the Portage FRM project and FIS update. In Mike Lesher's 2010 assessment of potential hydraulic connections he states that water must flow over a low point in County Road O, through culverts/bridges under the Soo Line RR tracks and Highway 16 or over the Soo Line RR tracks and Highway 16, then to Big Slough, to Neenah Creek, and finally to the Fox River. For a 10% chance flood there is no connection, but again from Mike Lesher's assessment, a connection exists for slightly greater than the 10% chance flood. Significant amounts of water are conveyed at this connection for larger flood events (e.g. 2900 cfs for the 2% chance flood). Based on an email from Robert Wakeman (WDNR) to Mike Saffran (USACE) on 8/11/2010, three connection points are identified for Portage upstream. These include two culverts under County Road O and a low point in County Road O. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins with a floodway shown from the Wisconsin River to Big Slough and Neenah Creek. During the site visit on 06-June-2011, no flow was occuring and it wasn't clear where the connection points were. Grassy and herbacious vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches from County Road O northeast to highway 16 and then a continuous channel (Neenah Creek) starting on the south side of highway 127 that continues to the Fox River.

Portage Upstream, Columbia County, WI - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**RC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	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: The ruffe and tubenose goby are located within the Great Lakes and are associated with river mouths and estuaries of large river systems entering the Great Lakes. The ruffe exists in northern Lake Michigan in Green Bay, but is not widespread and there are no high density populations in Lake Michigan (Bowen and Goehle, 2011). The ruffe prefers deep waters of lakes and pools of rivers, usually over sand and gravels but has a tolerance for different habitats and environmental conditions (Gray and Best, 1989). The ruffe has a high fecundity rate and spawns in clean water. Females produce up to 200,000 eggs in the first batch, and up to 6,000 eggs per subsequent batch (Global Invasive Species Database, 2012). The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures and turbid conditions. The ruffe has extended its range rapidly and modeling (USGS, 2012) predicts it will find suitable habitat in all five Great Lakes. The Tubenose goby is a benthic species that consumes a wide variety of invertebrates (USGS, 2011). They are found in the open waters and estuaries of slow flowing rivers and are often quite abundant in backwaters and lakes and seem to prefer dense vegetation. The tubenose goby's introduced range covers three Great Lakes including Lake Superior, Erie, and Huron (USGS, 2011). It has been collected in the lower reaches of larger Great Lakes rivers and estuaries, but no tubenose goby have been collected locally in upper Great Lakes river tributaries to date. Tubenose gobies have exhibited a much slower rate of expansion in the Great Lakes than the round goby (Neogobius melanostomus), also an invasive species in the Great Lakes and now located within both the Great Lakes Basin and the Mississippi River Basin. The tubenose goby's nearest locations are in Lake Superior and Lake Huron.
Both species are present on connected waterways, but neither tends to move up streams very far, so their likelihood of getting to the Portage Area within the next 20 years is unlikely.

Portage Upstream, Columbia County, WI - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul - Biologist	Low	RC	Low	RC
	USACE, Detroit - Biologist	Low	RC	Low	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RC	Low	RC
	Team Ratings	**Low**	**RC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	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: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. The divide location, consisting of more than a mile wide emergent and forested wetland complex and some agricultural land off the Fox River appears to be a viable barrier to further migration across the divide. The flooded farm land or emergent/forested wetland complex is not a preferred habitat for either the ruffe or the tubenose goby and the likelihood of either fish species crossing farm fields or emergent wetlands during a flood event is considered low as the flow of water is from the MRB to the GLB. If either of the fish species crossed the basin divide, sufficient forage, ranging from zooplankton to fish, is available on the MRB side of the divide to survive and prosper in the wider river segments of the Wisconsin River.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. There is no evidence or information to suggest the farm fields or emergent wetlands at the divide are recreational areas used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this location by anthropogenic means. Further, in the unlikely event these fish are introduced into the divide, the aquatic habitat is considered marginally suitable for survival of the ruffe/tubenose goby for at least the summer during most years. Transit across the watershed divide by other anthropogenic means is possible but unlikely because fishing and recreational boating do not occur at the divide. The ruffe/tubenose goby are listed among the "established nonnative fish species" (see WI NR 40.02(17)), which is one of four groups of "restricted" non-native fish species. Fish species in this restricted group may not be possessed, transported, transferred, or introduced without a permit from the WDNR. While it is feasible that either species could arrive at the divide by anthropogenic means, such as livewell or aquarium releases, that is also unlikely as these two fish species are not normally used as live bait for river fishing or aquarium species.

Portage Upstream, Columbia County, WI - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Low	RC		
	USACE, Detroit - Biologist	Low	RC		
	Wisconsin DNR, Fisheries Research Scientist	Low	RC		
	Team Ratings	**Low**	**RC**		

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	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 uncertainty regarding the suitability of the aquatic habitat to sustain a population of ruffe/tubenose goby in the upper Fox River and Portage Upstream divide wetland area. The ruffe is an aggressive species that possesses the ability to feed in darkness, cold temperatures, and turbid conditions. Tubenose gobies are benthic species that consume a wide variety of invertebrates (USGS, 2011). They are often quite abundant in backwaters and lakes and seem to prefer dense vegetation. Survival of a viable, reproducing population of ruffe and tubenose goby within the wetlands at the divide location is unlikely due to likely low water quality and high temperatures in summer months. These considerations were the primary basis for the low rating assigned to the probability that ruffe/tubenose goby could become established in close proximity to the basin divide at the upper Portage location.

Portage Upstream, Columbia County, WI - Ruffe (*Gymnochephalus cernuus*) / Tubenose Goby (*Proterorhinus semilunaris*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Low	RC		
	Team Ratings	**Medium**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	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: Ruffe and the tubenose goby have not been found in river systems similar to the upper Fox River. If the fish were introduced into the divide, they may be successful in passing through the pathway into the Mississippi River Basin.

Portage Upstream, Columbia County, WI - Threespine Stickleback (*Gasterosteus aculeatus*)

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, Detroit - Hydraulic Engineer	Medium	VC	Medium	VC
	USACE, Rock Island - Hydraulic Engineer	Medium	VC	Medium	VC
	NRCS - Hydraulic Engineer	Medium	RC	Medium	RC
	Team Ratings	**Medium**	**VC**	**Medium**	**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: Interbasin flows at Portage upstream (Lewiston Levee) are well documented as part of the Portage FRM project and FIS update. In Mike Lesher's 2010 assessment of potential hydraulic connections he states that water must flow over a low point in County Road O, through culverts/bridges under the Soo Line RR tracks and Highway 16 or over the Soo Line RR tracks and Highway 16, then to Big Slough, to Neenah Creek, and finally to the Fox River. For a 10% chance flood there is no connection, but again from Mike Lesher's assessment, a connection exists for slightly greater than the 10% chance flood. Significant amounts of water are conveyed at this connection for larger flood events (e.g. 2900 cfs for the 2% chance flood). Based on an email from Robert Wakeman (WDNR) to Mike Saffran (USACE) on 8/11/2010, three connection points are identified for Portage upstream. These include two culverts under County Road O and a low point in County Road O. The Columbia County FIS mapping clearly shows a connection between the Wisconsin and Fox River basins with a floodway shown from the Wisconsin River to Big Slough and Neenah Creek. During the site visit on 06-June-2011, no flow was occuring and it wasn't clear where the connection points were. Grassy and herbacious vegetation may have obscured this evidence. Aerial photography indicates intermittent ditches from County Road O northeast to highway 16 and then a continuous channel (Neenah Creek) starting on the south side of highway 127 that continues to the Fox River.

Portage Upstream, Columbia County, WI - Threespine Stickleback (*Gasterosteus aculeatus*)

2. Probability of ANS occurring within either basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	Medium	RC		
	USACE, Detroit - Biologist	Medium	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Rating	**Medium**	**RC**		

2. How do you rate the probability of ANS occuring within either basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS exists on connected waterways in close enough proximity to be capable of moving to the aquatic pathway within 20 years.
Medium	Target ANS exists on connected waterways, but based on current proximity and mobility, is considered incapable of moving to the aquatic pathway within 20 years.
Low	Target ANS is not known to exist on a connected waterway.

	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: The threespine stickleback is found in each of the Great Lakes and has been collected in some inland river systems (USGS, 2011). Literature indicates this species prefers to live in smaller streams but may occur in a variety of habitats including lakes and large rivers. The threespine stickleback was first encountered in lower Green Bay and the Lower Fox River (below DePere Dam) about 25 years ago, but has never been seen upstream from this area. Great Lakes populations of this species tend to be potamodromous (truly migratory but within fresh water only) and only enter the lower reaches of streams briefly during spring spawning. Because of this, they are found on connected waters, but migration to the divide location within the next 20 years is very unlikely.

Portage Upstream, Columbia County, WI - Threespine Stickleback (*Gasterosteus aculeatus*)

3. Probability of ANS surviving transit to aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	3A Rating	Certainty	3B Rating	Certainty
	USACE, St. Paul - Biologist	Low	RC	Low	RC
	USACE, Detroit - Biologist	Low	RC	Low	RC
	Wisconsin DNR, Fisheries Research Scientist	Low	RC	Low	RC
	Team Ratings	**Low**	**RC**	**Low**	**RC**

3A. How do you rate the probability of ANS surviving transit to aquatic pathway through connecting streams?

3B. How do you rate the probability of ANS surviving transit to aquatic pathway through other means?

Qualitative Rating	Qualitative Rating Category Criteria
High	Target ANS are established in relatively close proximity to location and have ample opportunity, capability and motivation to successfully navigate through the aquatic pathway and/or through other means to arrive at the subject pathway within 10-20 years.
Medium	Target ANS are established at locations in close enough proximity to location and have limited capability to survive passage through the aquatic pathway or through other means to arrive at the subject pathway within 20-50 years.
Low	Target ANS are not in proximity to the pathway, and/or it is highly unlikely that they could survive transit from current locations by aquatic pathway or other means to arrive at subject pathway within next 50 years.

	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: 3A. Probability of ANS Surviving Transit to Aquatic Pathway Through Connecting Streams.

3A. The threespine stickleback has been found in the Great Lakes and in smaller river systems. While not having been identified within the Upper Fox River, its close proximity in the Great Lakes indicates potential for access and transfer to the Mississippi River Basin. Section 2.7 describes the dams as potential obstacles to upstream migration to the MRB/GLB divide. The literature does not indicate a propensity to migrate upstream during runoff events. The mile wide farm field and emergent wetland divide should be sufficient in impeding migration of the threespine stickleback at all flow conditions as flooded farm field and emergent wetland is not a preferred habitat. Sufficient forage and habitat appear to be available throughout the Upper Fox River and MRB for the threespine stickleback, thus the rating and certainty.

Remarks: 3B. Probability of ANS Surviving Transit to Aquatic Pathway Through Other Means

3B. There is no evidence or information to suggest the emergent wetland is a recreational areas used by fishermen or boaters, so there appears to be a low probability for ANS to be transported to the proximity of the basin divide at this location by anthropogenic means. It is believed that bait-bucket transport has aided in the movement of the threespine stickleback in the past. The threespine stickleback is listed among the "established nonnative fish species" (see WI NR 40.02(17)), which is one of four groups of "restricted" non-native fish species. Fish species in this restricted group may not be possessed, transported, transferred, or introduced without a permit from the DNR. Since fishing and boating are not recreational uses that occur at the divide, it is unlikely that the species would arrive at the divide by anthropogenic means. If the fish were dumped into either the Wisconsin or the Upper Fox River, it is likely they would survive and migrate downstream. Education will be critical to minimizing accidental introductions through this pathway, thus the rating and certainty.

Portage Upstream, Columbia County, WI - Threespine Stickleback (*Gasterosteus aculeatus*)

4. Probability of ANS establishing at the aquatic pathway

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty
	USACE, St. Paul - Biologist	Medium	RC
	USACE, Detroit - Biologist	Medium	RC
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC
	Team Ratings	**Medium**	**RC**

4. How do you rate the probability of ANS establishing at the aquatic pathway?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are plentiful in close proximity to support all life stages from birth to adult, abiotic conditions align with native range and there are no known predators or conditions that would significantly impede survivability or reproduction.
Medium	Limited and disconnected areas and sources of food and habitat suitable to the ANS are available in proximity, abiotic conditions are within latitude limits of native range, but only a portion of the healthy individuals arriving at location can be expected to effectively compete and survive.
Low	Habitat and abiotic conditions in proximity are outside the range where ANS has been known to survive; there is very limited availability habitat area suitable for ANS cover, sustainable food supply and reproduction; or native predators or competition with native species would likely prevent establishment of a sustainable population.

	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: As a visual predator, the sometimes turbid waters of the Upper Fox River at the divide may be unsuitable for the threespine stickleback. Survival of a viable, reproducing population of threespine stickleback within the rivers adjacent the divide is feasible. The Upper Fox River would appear to provide sufficient habitat for colonization by this species.

Portage Upstream, Columbia County, WI - Threespine Stickleback (*Gasterosteus aculeatus*)

5. Probability of ANS spreading across aquatic pathway into the new basin

Aquatic Pathway Team	Expertise Position title or team role	Rating	Certainty		
	USACE, St. Paul - Biologist	High	RC		
	USACE, Detroit - Biologist	High	RC		
	Wisconsin DNR, Fisheries Research Scientist	Medium	RC		
	Team Ratings	**High**	**RC**		

5. How do you rate the probability of ANS spreading across aquatic pathway into the new basin?

Qualitative Rating	Qualitative Rating Category Criteria
High	Sources of food and habitat suitable to the ANS are available, and the species has demonstrated capabilities to significantly expand range from locations where initially introduced.
Medium	There are limited sources of food and suitable habitat, and/or the species has demonstrated limited ability to spread significant distances beyond areas where it has been introduced.
Low	There are severely limited sources of food and suitable habitat, and/or the species has demonstrated very limited ability to spread beyond areas where it has been introduced.

	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: If the threespine stickleback were introduced into the rivers adjacent the divide, it is highly likely that the fish would survive and pass through the Portage Upstream pathway into the Mississippi River Basin during a suitable flood event.