Gaining Insight into GLMRIS:

An Investigation of the Benefits & Costs of the Alternatives in the Great Lakes & Mississippi River Interbasin Study

Chaddick Institute for Metropolitan Development

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Executive Summary

This study offers a perspective on benefits and costs of alternatives explored in the U.S. Army Corps of Engineer's Great Lakes and Mississippi River Interbasin Study Report (GLMRIS) released on January 4, 2014. The study offers insights into the tradeoffs associated with the six "structural" options identified to achieve the partial or total separation of Great Lakes and Mississippi River basins on the Chicago Area Waterway System (CAWS).

The report makes a particular effort to explore: i) the relative benefit and costs of separation based on estimates provided in the report; ii) factors identified, but not measured, in the report, such as the cost of land acquisition and water quality impacts; and iii) the chances of successful implementation given the long project timelines and distribution of ongoing costs after completion, which will be borne heavily on local businesses, citizens, and institutions.

The study does *not* attempt to assess the validity of the estimates or implementation timetables in GLMRIS. Instead, it uses the study's findings as inputs for statistical evaluation to better understand the tradeoffs and desirability of various alternatives. Three of the most significant conclusions from this study include:

1. The total costs of the alternatives range from $13 - $34 billion over the study's 50 year horizon used—more than twice the construction costs. The lengthy period of expenditures, with many costs being incurred several decades before benefits are realized, greatly hampers the economic viability of the alternatives.

When all relevant factors are taken into account, including real estate expense and the opportunity cost of capital, the necessary expected benefits for four of the six alternatives must be approximately $2 billion *per year* to justify the costs. At the same time, funding for this project must compete with other needs in which the benefits are achieved on a much quicker timeline, putting it at a sharp disadvantage.

2. The implementation timelines, with all but one spanning 25+ years, create significant uncertainty about project benefits.

Unlike most large-scale infrastructure projects, in which the benefits tend to rise over time, the expected benefits of the alternatives will likely decline due to the transfer of aquatic nuisance species (ANS) between the basins before the project's completion—either through CAWS or other waterways—or that scientific advancement will result in a less costly alternative before the project is completed.

3. The tendency for many of the costs to be borne by Chicago area citizens, businesses, and government institutions —totaling more than $1.5 billion in some alternatives—will create an unfavorable dynamic that makes this project politically risky and potentially controversial among stakeholders in the area.

For a project of this scale to succeed, a coalition of local governments must emerge to provide leadership, matching funds, and political salesmanship. Without the benefits of this, all six alternatives will have a high risk of being left to linger after construction begins.

This study found that a more robust estimate of expected benefits and the accompanying risks are needed before implementation begins.

Background

Public understanding of the threats posed by aquatic nuisance specifies (ANS) in the Great Lakes Region has risen sharply since the U.S. Congress authorized work on the U.S. Army Corps of Engineer's Great Lakes and Mississippi River Interbasin Study (GLMRIS) study in 2007. Concern over the migration of various invasive species, most notably the bighead and silver (Asian) carp, has escalated as the implications of this migration are better known. An estimated 25 ANS are at risk of transferring from Great Lakes to the river system, while another ten, including the Asian carp, are at risk of migrating from the river system to the Great Lakes. Other ANS threats may emerge in the years to come.

In the process, extensive research exploring the possibilities for separating the Great Lakes and Mississippi River Basins has become available. Among the most notable works include a study by the Great Lakes Commission and the Great Lakes and St. Lawrence Cities Initiative. This 2012 study explores the costs and benefits of separating the basins in much the same way as the GLMRIS study does. Additional research by the Alliance of the Great Lakes, Friends of the Chicago River and Metropolitan Planning Council draws attention to the importance of a vibrant and healthy CAWS. Similarly, government agencies have also taken positions—backed in some cases by legal action—in response to the ANS threat.

Users of CAWS, meanwhile, have explored the consequences of various alternatives to the region's economy, such as their negative effects on improvements to the Port of Chicago, the movement of cargo barge and deep-draft vessels, and commercial passenger and recreational boat operators. As a result, the GLMRIS study comes at a time of considerable anticipation about possible "next steps" to deal with ANS threats.

Categories of Costs

The GLMRIS study identifies several basic categories of costs that would be incurred by separating the water basins. These estimates include expenses associated in areas such as transportation, flood management, and tourism. The four main categories include:

Commercial Cargo Navigation Costs: Providers and users of waterborne cargo would be heavily affected under some alternatives, particularly those erecting barriers to separate the basins. The costs would be distributed primarily between: i) barges operating to and from points on the Mississippi River and its many tributaries, and ii) deep draft vessels ("lakers"), operating between the river system and from points on Lake Michigan and beyond.

Barge users have a particular stake in continued navigation of the Cal-Sag Channel, a largely man-made canal through the southern part of the region providing access to the inland river system. Deep draft vessels operating to and from the Port of Chicago and Calumet River also have a large stake in maintaining the link between CAWS and Lake Michigan. The GLMRIS study forecasts that the amount of commercial traffic along this route will grow by 45% through 2020 (p. D-23) and that separation of the basins would require many shippers of waterborne cargo to turn to other modes of transport. [1]

Figure 1: **Chicago Area Waterway System**

Non-Cargo Navigation Costs: This category of costs includes losses to commercial passenger, recreational, charter, and fishing boats, as well as to government agencies using the locks, such as the Chicago Fire Department. These costs include the lost value from disruption to varying degrees to the estimated 712,000 passengers who move through the Chicago Lock annually. The GLMRIS study does not attempt to estimate possible future growth, perhaps due to reliable tools to make such forecasts. The study, however, does estimate the value that consumers derive from the use of CAWS.

Flood Risk Management (FRM) Costs: The study estimates both the expected damages from flooding and the costs of necessary measures to mitigate the risk of flooding. Under some of the proposed alternatives, these measures center heavily on the need for additional reservoir capacity at McCook and Thornton, Ill., as well as building new tunnels to allow water to reach these reservoirs under certain scenarios. While the GLMRIS study measures the acreage needed and probable sites for such reservoirs, it shies away from estimating the cost of land acquisition. To develop an understanding of these total costs, an approximation is made below. As noted in the endnotes, additional consideration of impacts in Indiana may also be necessary to develop a truly comprehensive FRM estimate.2

Water Quality Impact Costs: The study considers the need for additional water treatment facilities to allow for water to bypass the separation barriers and GLMRIS Locks. Extensive attention is given to the issue of changing water quality resulting from different flow patterns, as well as the problems posed by

the higher standards of water entering Lake Michigan than the river system. The study, however, does not attempt to measure the cost of reductions in water quality nor the cost of environmental cleanup.

Among the other factors not considered in the GLMRIS study are the costs of environmental review and regulatory compliance (see page 90).

The GLMRIS study estimates that each year of delay would result in an additional 3-4% construction cost, and the agency would need time for both environmental review, and permitting, and an estimated 24 months to acquire real estate. This study is explicit in noting that delays would drive up costs. Due to the documented need for time required for the above activities, construction costs in the GLMRIS study are increased by a nominal 10% in the analysis below. This appears to be a lower-bound estimate and is based on approximately three years being added to the construction timetable.

Study Critique

The following analysis looks at the six "structural alternatives" presented in the GLMRIS study:

3. Mid-system GLMRIS Locks: A technology concept involving a specialized lock, lock channel, electric barriers and ANS treatment plants at two mid-system locations in the CAWS (25-year implementation timeline).

4. Lakeside GLMRIS Locks +screened sluice: A concept (CAWS buffer zone) using the same technologies as number 3, preventing downstream passage from Lake Michigan at five points and preventing upstream passage at a single point at Brandon Road Lock and Dam. Water flows through a screened sluice between the river and lake (10-year implementation timeline).

5. Lakefront hydrologic separation: Physical barriers separating the basins at four locations along the lakefront of Lake Michigan (25-year implementation timeline).

6. Mid-system hydrologic separation: Physical barriers separating the basins at two mid-system locations (25-year implementation timeline).

7. Mid-system Separation, CalSag Open: A hybrid of technology and physical barriers at four mid-system locations, leaving the Cal-Sag Channel open (25-year implementation timeline).

8. Mid-system Separation, CSSC Open: A hybrid of technology and physical barriers at four mid-system locations, leaving the Chicago Sanitary and Ship Canal open (25-year implementation timeline).

The present study does not consider the two incremental alternatives—number 1: "no federal action," and number 2: "nonstructural control technologies—as neither requires capital outlays nor would significantly affect water flows between the basins.

Based on the review of these alternatives, the following conclusions were made:

1. The cost of the alternatives ranges from $12.9 - $31.2 billion when considering the combined effects of construction costs and ongoing costs over a 50 year horizon. To justify the expense, the necessary benefits after completion would need to be between $436- $1.2 billion annually, depending on the alternative. These estimates do not include the opportunity costs of capital, which drive up the necessary level of expected annual benefits much higher.

The estimates of the cumulative 50-year costs are determined by evaluating the costs provided in the GLMRIS study and taking into account whether these are on-time or annual expenses. These estimates represent additional costs above and beyond the "continue existing operations, no new build" scenario. They include the costs of maintaining the system after construction ends, as well as the additional costs borne by users of the system, including cargo shippers and passenger vessel operators.

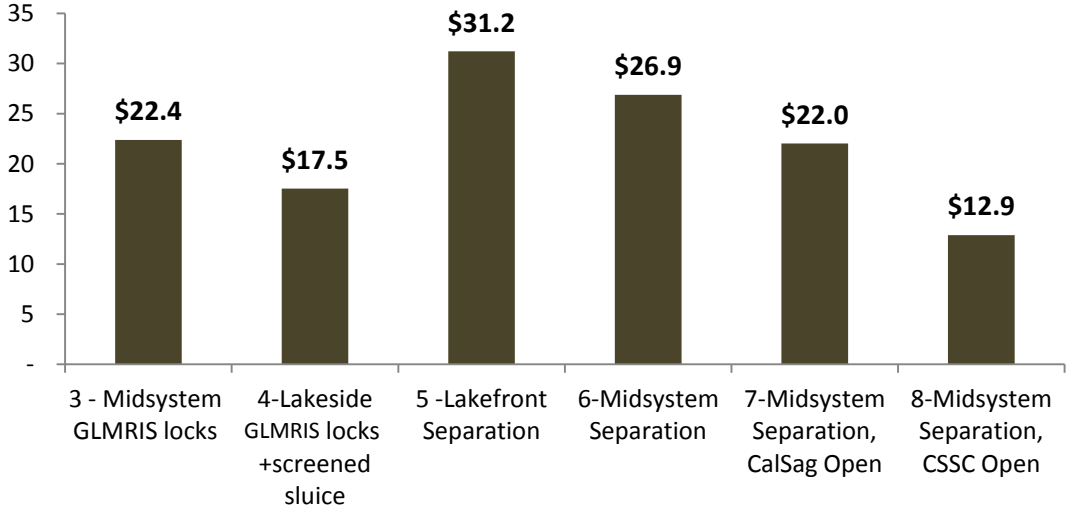
These estimates include a relatively conservative estimate of the cost of land acquisition, which is based on the number of acres of land the report indicates are needed to be purchased to expand reservoir capacity and make other improvements. Estimates are based on an average acquisition cost of $50,000/acre in areas outside of downtown Chicago, a standard used by the Cook County Forest Preserve District for its land acquisition, and $7.5 million per acre of land purchased in downtown Chicago. As discussed in the e*ndnotes*, these estimates likely understate the cost of land by a considerable margin. The costs of acquiring *developed* property, for example, would be much higher.[3]

Figure 2

Cumulative Cost of Structure Alternatives

Costs in Bllions Above and Beyond the Continuation of Existing Operations

50 Year Total Including Estimated Land Acqusition Expense



The cumulative 50-year cost appears in *Figure 2*. The alternatives involving GLMRIS Locks—numbers 3, 4, 7 and 8—are appreciably less expensive than the separation alternatives—numbers 5 and 7— even though the locks would require significant additional operating costs in the form of maintenance and operation.

In order for such investment to have a positive payout (ignoring the time value of money, which is considered below), the required annual benefits to justify the costs range from $436 million—number 2—and more than $1.1 billion for the two alternatives—numbers 5 and 6— involving full separation (*Table 1*). As noted earlier, the primary anticipated benefit is a reduction in the probability of negative environmental impacts due to ANS transfer between the basins.

Table 1

Required Annual Benefits to Justify Investment in Separation Alternative

In 2014 Dollars w/o Adjusting for Time Value of Money (NPV)

3. Mid System GLMRIS Locks:	**$893,850,000**
4. Lakeside GLMRIS Locks with Screened Sluice (and buffer zone)	**$435,570,000**
5. Lakefront Separation	**$1,122,613,000**
6. Midsystem Separation	**$1,074,700,000**
7. Midsystem Separation – Cal Sag Open	**$897,940,000**
8. Midsystem Separation – CSSC Open	**$824,540,000**

Whether the proposed benefits would be sufficient to offset these costs is considered in greater detail in *Finding 3*.

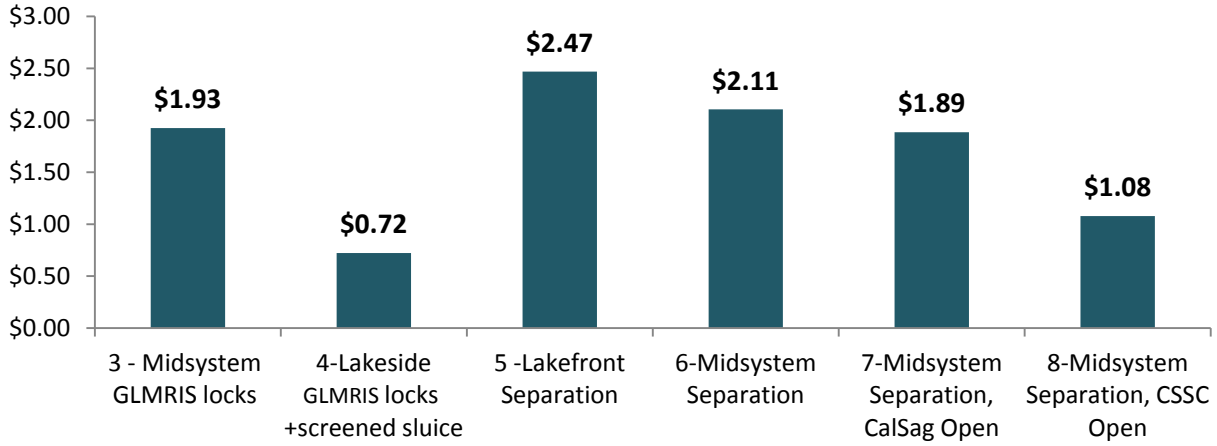
2. When standard assumptions about opportunity costs of capital are made, the annual benefits required to justify the expenditures range from $720 million and $2.47 billion, annually, depending on the alternative. These estimates, based on the 3.5% discount rate used in the study, take into account the fact that some funds are needed for construction more than 15 years before the benefits are achieved. When higher 5% discount rates are used, the required annual benefits rise to as much as $3.18 billion, an extremely difficult threshold to reach.

All investments have opportunity costs. If funding is set aside for the project, that same funding will be unavailable for other purposes. Accordingly, if figures are adjusted to the net present value using the GLMRIS 3.5% discount rate, the "break even" level of benefits needed to justify the projects rises by more than 50%, to between $720 million and $2.46 billion, annually (*Figure 3*). Considering the risks associated with the project—and the severe shortfalls of capital for basic rehabilitation of other parts of the nation's infrastructure, such as the Highway Trust Fund, capital investment in transit, and aging inland waterway facilities—one could make an argument that the discount rate should be appreciably higher. If a 5% discount rate is used, for example, the required annual benefits to justify the project rise to between $860 and $3.18 billion. (See Table 4 in the endnotes for an analysis using various discount rates).[4]

Figure 3

Necessary Annual Benefits to Justify Investment

50 year total in Billions with NPV adjustment



To make the argument that time value of money considerations are to be ignored, a case needs to be made that the project should be regarded entirely as an intergenerational transfer—akin to a gift—from the present to future generations. A philosophical decision would need to be made that the project should proceed without considering its opportunity costs to the present generation. As noted in *Finding 3*, current evidence does not appear to be available to document that the expected benefits, given the risk of project failure, are sufficiently high enough to justify the costs.

3) **Unlike most large-scale infrastructure projects, in which the benefits tend to rise over time, the expected benefits of the alternatives will likely decline due to the risk that ANS will enter the lake before the project's completion (either through CAWS or other waterways) or that scientific advancement in dealing with ANS will result in a less costly alternative before the project is completed. Due to these risks, measuring the expected benefits will require a far more elaborate analysis than has been provided to-date.**

The analysis presented in *Findings 1 and 2* suggests that the structural alternatives can be justified only if they achieve some minimum level of expected benefits, which in some cases is estimated to be more than $2 billion/year. At the same time, the analysis in the GLMRIS study states that there is a significant probability that many of the identified ANS species will already be established in Lake Michigan through one of the five access points on CAWS within 25 years. It assigns the risk of bighead and sliver carp doing so to be "medium (M)," meaning "the event is likely to occur but is not certain to do so." The chance that scud will have established itself in the Mississippi River basis is rated as "high (H)," meaning "the event will almost certainly occur" (*Table 2*).

Table 2:
GLMRIS Estimates of Length of Time before ANS Transfer Across Basins

	Time Period		
Nuisance Species	**10 Years**	**25 Years**	**50 Years**
Bighead Carp	**L**	**M**	**M**
Silver Carp	**L**	**M**	**M**
Scud	**H**	**M**	**M**

H = high probability, the event will almost certainly occur; M = medium probability, the event is likely to occur but is not certain to do so; L = low probability, the event will likely not occur but is possible.

The study also emphasizes that it did not consider the risk that ANS will transfer between basins on waterways outside of CAWS. Much consideration has been paid to this risk by policymakers in recent years, which suggest this risk needs to be explicitly incorporated into a cost-benefit analysis.

These issues suggest that the expected benefit calculations need to be a weighted average of the chance of "project success" (i.e., an outcome in which nearly all the potential ANS benefits are achieved) and the chance of "project failure," (i.e., an outcome in which the ANS benefits are far less than their maximum potential). It is easy to understand how the latter might drive expected benefits downward. If, for example, 50% of the potential ANS benefit will be lost due to ANS establishing themselves in the lake within 25 years, then the expected benefit associated with a successful project outcome for this species would have to be 1.5 times the cost to justify the investment. Although it is certainly possible that such a justification can be made, more careful considerable of the probability of a failed outcome is clearly needed.

For purposes of perspective, it is useful to note that achieving a $2.1 billion expected annual benefit equates to demonstrating a $103 benefit per household in the entire Great Lakes region.[5] The cost of monitoring and controlling zebra mussels in the Great Lakes has reached at least $30 million annually.[6] The evidence suggests that it will be extremely difficult to demonstrate using existing evidence the project will achieve the expected benefits, given the risk of project failure.

3. The lengthy timelines for the proposed projects create significant implementation complexity due to the unpredictability of federal funding, particularly for the 25-year alternatives. This complexity is magnified by the tendency that many costs will be borne locally, in the form of losses to businesses and homeowners, as well as flood risk mitigation expenses. This adds to the risk that local funding partners will not have sufficient political support to overcome irregularities in federal funding.

Pursuing any of the alternatives would require a sharp rise in federal allocation for work on the inland waterways. Presently, ACE receives about $2 billion in construction funding annually for all of its construction projects *nationwide*. It appears likely that, under some alternatives during some years, upwards of $1 billion annually will be needed for this new project alone.

This is not to say that infrastructure projects with long implementation timetables cannot succeed. In the Chicago region, CREATE, the $3.2 billion program to alleviate rail congestion, and the O'Hare Modernization project ($8.7 billion) are both progressing favorably[7]. Similarly, the Illinois Toll Highway Authority's capital improvement program ($12 billion) appears to be going relatively smoothly.

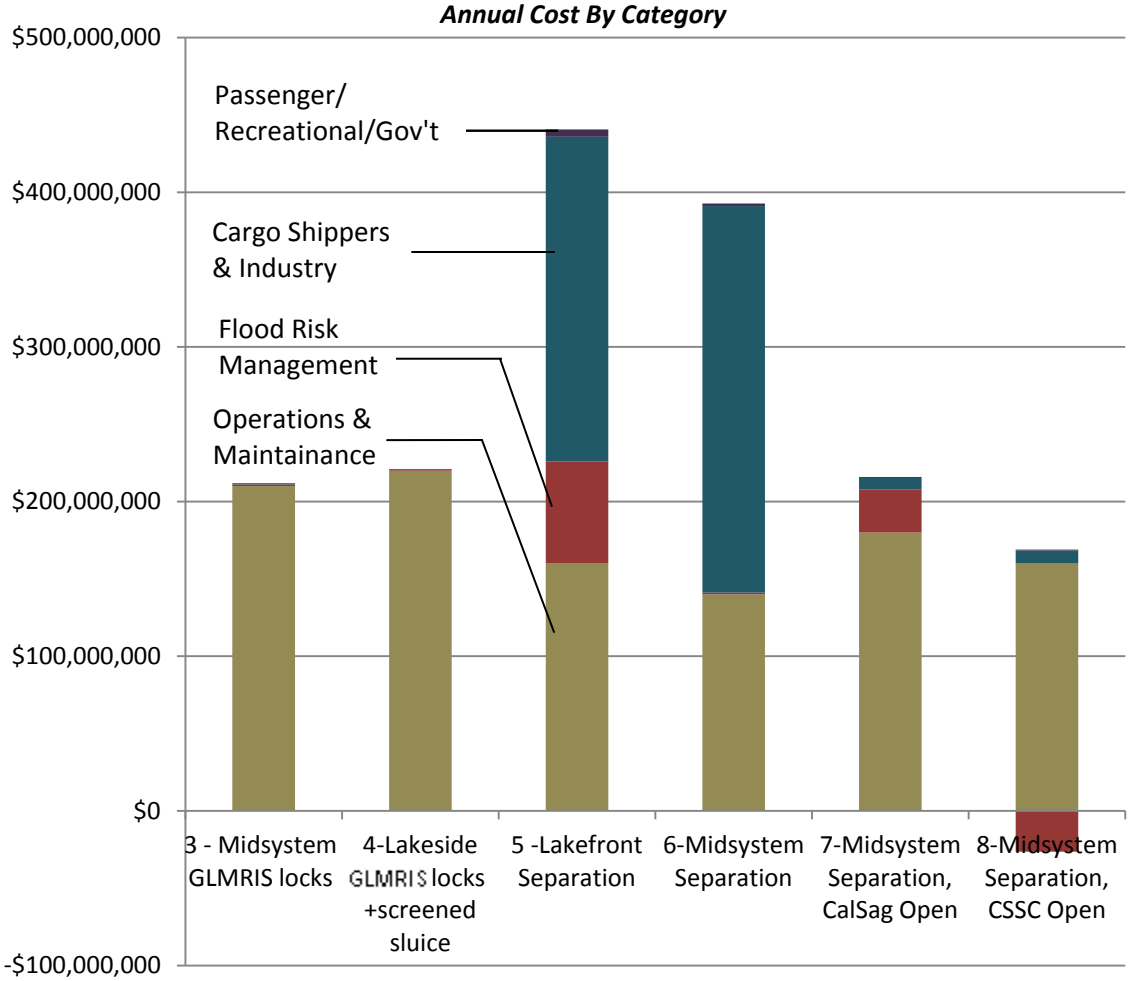
Among the key differences, however, is that a significant share of these established projects are financed by users. Each project draws upon funds provided by residents and businesses reaping direct benefits. A waterway separation project would not have this advantage, as it is unlikely Chicago-area residents will be willing to finance improvements with benefits that tend to be national (or regional) in orientation. The project would likely have the benefit of a coalition of Great Lake states, which cumulatively wield significant power in the U.S. Congress. It is unclear, however, how many states would (or legally could) offer matching-funds support for projects in Illinois.

Figure 4 shows the portion of costs *after project completion* that would likely be heavily borne by local vs. federal entities. The tan areas are operations and maintenance expenses, which would be borne principally by federal agencies. The blue, pink, and purple areas are at risk of being mostly borne by users of cargo transport, flood-control units, and non-cargo users of the system, respectively. For both of the separation alternatives, as well as the Cal-Sag Open/Midsystem Separation alternative, the local impacts are particularly large, totaling more than $200 million annually to users of cargo transport, not including flood control and passenger vessel costs. As noted in the conclusion, these costs create a difficult political dynamic that could impair successful implementation.

Figure 4

Distribution of Cost Burden After Project Completion

Annual Cost By Category



5. Including costs identified but not measured within the GLMRIS study would conservatively add $20 million - $0.98 billion to total costs. The burden of these expenses include the external costs of cargo moving to other modes, depreciated property values, and reduced water quality in Lake Michigan. Although these are only general estimates, they point to the need to consider all expenses.

To assess the relative magnitude of costs not considered in the study, some simple calculations are made. This offers insight into three particularly prominent areas:

External costs from added truck/rail traffic, estimated at $228 million/annually: An earlier study by this author, published in 2010, estimates the costs of the transfer of cargo to more heavily polluting modes to be $228 million/annually. This includes uncompensated wear-and-tear on highways, pollution, and traffic-safety costs. A proportion of these costs were assigned to the alternatives, based on impact, as described in the e*ndnotes*[8].

Water-quality impacts on river system: These costs remain mostly in the realm of speculation. The previous (2010) report by this author estimated that property values near the river downtown would fall by 0.5%, resulting in a one-time $51 million drop in value. These costs were assigned in full to the two alternatives in which the impacts were determined to be "high" in the GLMRIS study and at 50% of this level for the alternatives in which the impacts were "moderate," as described in the *endnotes*.[9]

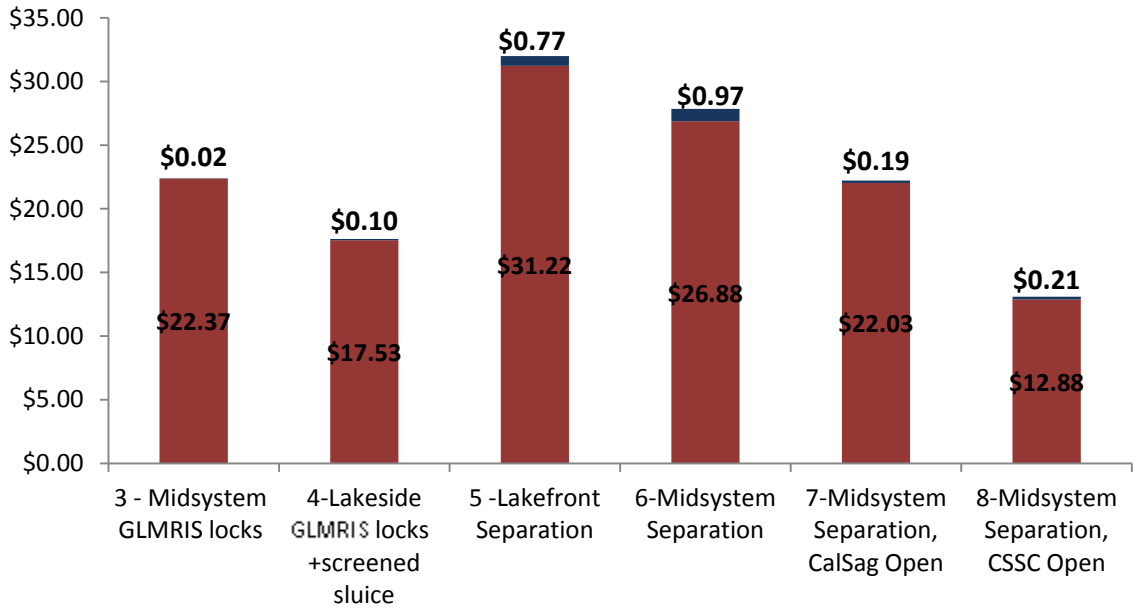
Water-quality impacts in Lake Michigan*:* Costs of beach closings due to water-quality issues as a result of stormwater runoff are estimated in the GLMRIS study to be $17 million annually. The study also notes that diminished water quality in CAWS would have negative impacts on the lake in some scenarios. Assuming the severity of the closings would rise by 40% in the "high negative impact" scenarios, and half this amount would result from the moderate impact scenarios, the additional costs would range from $3.4 million to $6.8 million annually. These estimates are, of course, somewhat speculative but illustrate how even marginal changes can generate millions in annual costs.

The analysis suggests that these costs are significant in absolute terms, adding between $20 million and $0.97 billion *(Figure 5*) to total project expenses. Additional expenses for flood control not measured in the study might also be necessary in northwest Indiana (see *endnote 2* for a summary).

Figure 5

Upward Adjustment in Cost Due to Consideration of External Costs & Certain Water Quality Impacts

50 year total in Billions w/o NPV adjustment



Conclusion

This report reviews the GLMRIS study and uses statistical evaluation to better understand the tradeoffs and desirability of the various alternatives that have been provided in previous analyses. It aims to understand the full costs of the proposed alternatives and the chances of their successful implementation. Three of the most significant conclusions from this study include:

1. The implementation timelines, particularly for the five 25-year alternatives, create significant uncertainty about project benefits.

As noted earlier, the proposed timelines presented in the GLMRIS study do not include environmental review, which would likely add 3—4 years to implementation. This further increases the probability that ANS will have migrated between the basins before the project's completion. Regardless, there is a high probability that the profile of benefits in 25 – 29 years will look quite different than they do today due to climate change, scientific advancement in dealing with the migration of species, the spread of ANS through waterway within and outside of CAWS, and technological change in the management of waterways.

2. The sizable costs—which total $12 – 31 billion for the alternatives over 50 years—and temporal pattern of investment, with the costs being incurred many years before benefits are realized, greatly hampers the economic viability of the structural alternatives.

Funding for this project must compete with other alternatives in which the benefits are achieved much quicker, putting it at a strong disadvantage with other funding needs. Alternative 3, the only structural option with a ten-year build-out, which proposes the use of GLMRIS Locks with a buffer zone, deserves special mention for being comparatively less expensive, as a whole and specifically for the Chicago metropolitan region.

3. The tendency for many of the costs to be borne by Chicago area citizens, businesses, and government institutions will create an unfavorable dynamic that makes this project politically risky and potentially controversial among taxpayers.

For the project to succeed, a coalition of local governments must emerge to provide leadership, matching funds, and political salesmanship. Without the benefits of this, all six alternatives will have a high risk of being left to linger after construction begins.

The transfer of ANS between the basins is worthy of a great deal of policymaker attention and heightened public investment due to the potential threat to the Chicago region's environmental and economic well-being. Before taking action, however, policymakers and other stakeholders involved in the decision making process should carefully analyze the high (and currently unaccounted-for) *total* project costs highlighted in this report. They must also consider whether the project will generate enough benefits to the region needed to justify these costs, as well as the likelihood that the project will not be completed in time or will fail after implementation.

References

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U.S. Army Corps of Engineers. Great Lake and Mississippi River Interbasin Study Report (GLMRIS), January 6, 2014.

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[1] The estimate that cargo traffic will rise by 45% also includes traffic that already exists but is not captured in Army Corps of Engineers reports.

[2] Due to the expedited timeframe in which the Corps was required to submit the final GLMRIS report to Congress, the flood risk management portion is predominantly focused on the Chicago impact. Whereas the proposed new tunnels to divert stormwater from Indiana's Grand and Little Calumet River watersheds are included in cost estimates, the report does not appear to go beyond these costs estimates and impacts. To date, over $500M has been spent on the two river systems for flood control as well as remediation/restoration efforts. Without evaluation of impacts to these projects, the costs associated with the flood risk management section are woefully short as they relate to Indiana impacts. (I have submitted a request for clarification from the Corps on this but do not anticipate a speedy response).

[3] The GLMRIS study estimates the real estate value, the administrative costs, and the utility relocation costs associated with each land acquisition for each alternative. These estimates, however, are not included in the cumulative cost estimates of the alternatives presented in the report's Executive Summary. To develop an independent perspective on land acquisition costs, the author reviewed the amount of land needed to be purchased in "fee simple." Cost estimates were made based on an acquisition cost of $50,000/acre in outlying areas and $7.5 million in the downtown area. The latter appears to be conservative. A vacant 5.09 parcel at 978 S. Wells along the South Branch of the Chicago River is presently listed for $25 million, or about $4.91 million per acre. (See: www.landandfarm.com/property/5_ACRES_ON_CHICAGO_RIVER-426335/). This parcel is a considerable distance from the downtown core. Property at 401 N. Wabash was sold for $43 million/acre to allow for construction of the Trump Tower. Another undeveloped parcel, measuring .12 acres, at 17 E. Illinois Street, is presently listed for $2.1 million, or about $18 million/acre. (See: www.loopnet.com/Listing/18447969/17-E-Illinois-Street-Chicago-IL/). It is possible, therefore, that land costs will be two or three times the $7.5 million/acre estimate. Obviously, buying a developed parcel would entail a much larger expense, including costs associated with building demolition. In addition, land purchased through eminent dominant is typically purchased at a premium over market value. The estimated $50,000 cost/acre of outlying land is based on the *2012 Land Acquisition Plan* by the Cook County Forest Preserve District. This document is available at: pdcc.com/downloads/FPDCC2012LandAcquisitionPlanFinal.pdf

[4] A summary of the sensitivity of the results under different discount rate assumptions appears in *Table 3* below.

Table 3:

Necessary Annual Benefits to Justify Costs at Various Discount Rates

(In billions of dollars)

	3.5%	***5%***	***6.5%***
Alternative Number	% Impact	% Impact	Annual Cost ($)
#3	$1.93	$2.5	$3.51
#4	$0.72	$0.86	$1.05
#5	$2.47	$3.18	$4.34
#6	$2.11	$2.70	$3.69
#7	$1.89	$2.47	$3.43
#8	$1.08	$1.40	$1.94

[5] The Great Lakes Legislative Caucus estimates that 25 million Americans and 8.5 million Canadians live in the Great Lakes Basin. See: www.greatlakeslegislators.org/AboutUsAndTheLakes/GreatLakesFactsAndFigures/tabid/70/Default.aspx

[6] The ANS task force estimates that $30 million is spent annually in the Great Lakes to monitor and control zebra mussels. See also page 1 of the GLMRIS report for a summary of the zebra mussel and other ANS.

[7] For a summary of these costs, see the American Society of Civil Engineers description at: www.asce.org/cemagazine/Article.aspx?id=23622328789

[8] The author's earlier study, *Costs of Terminating Lock Operations on the Chicago Area Waterway System* (available at las.depaul.edu/chaddick), estimates that the cost of lakeside separation to be $228 million annually. A fraction of these costs were applied to the various alternatives based on the proportional share of impact they would have on cargo operations and noted in *Table 4*.

Table 4:

External/Environmental Costs

(In millions of dollars)

	External Costs - Transportation		***Property Impact***		***Beach Closings***	
Alternative Number	% Impact	Annual Cost ($)	% Impact	One-Time Cost ($)	% Impact	Annual Cost ($)
#3	0	0	0	0	0	0
#4	0	0	0	0	0	0
#5	100%	$29.8	50%	$25.5	0	0
#6	100%	$29.8	100%	$51.0	40%	$6.8
#7	10%	$3.0	50%	$25.5	20%	$3.4
#8	10%	$3.0	100%	$51.0	20%	$3.4

For a discussion of external costs due to the modal shift in transportation, see Schwieterman (2010), pages 11-12. For a discussion of property impact, reference the above study, pages 16-17.

[9] There is a particularly extensive literature, however, on the elasticity of property values with respect to water quality (as measured by the percent change in contaminants in the water). Using an estimate near the median of the elasticity estimates made in these studies (.05), and assuming a hypothetical 10% reduction in water quality due to waterway separation, the property impact is determined to be $51 million. See Schwieterman (2010), page 16-17. A proportion of these costs, based on the rating of the water-quality impact in the GLIMIR study, is assigned to each alternative, as noted in *Table 4* above.