AQUATIC NUSIANCE SPECIES AND THE CAWS

Metropolitan Mayors Caucus

HDR

June 3, 2015

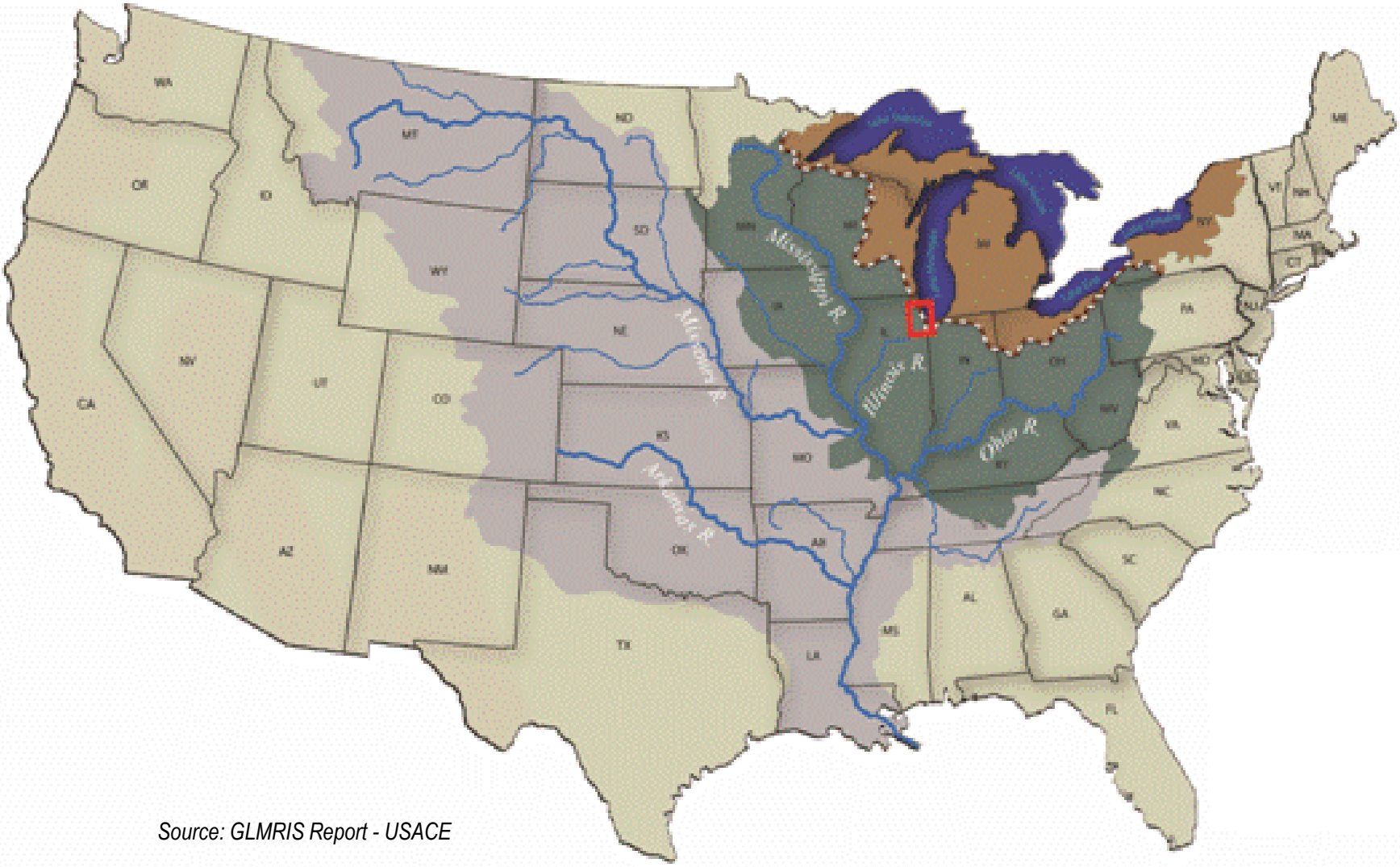
OUTLINE

- CAWS Background
- Aquatic Nuisance Species (ANS)
  - Background
  - Risk & Impacts
  - Risk reduction measures
- Information presented to the Advisory Committee

WORKING CRITERIA

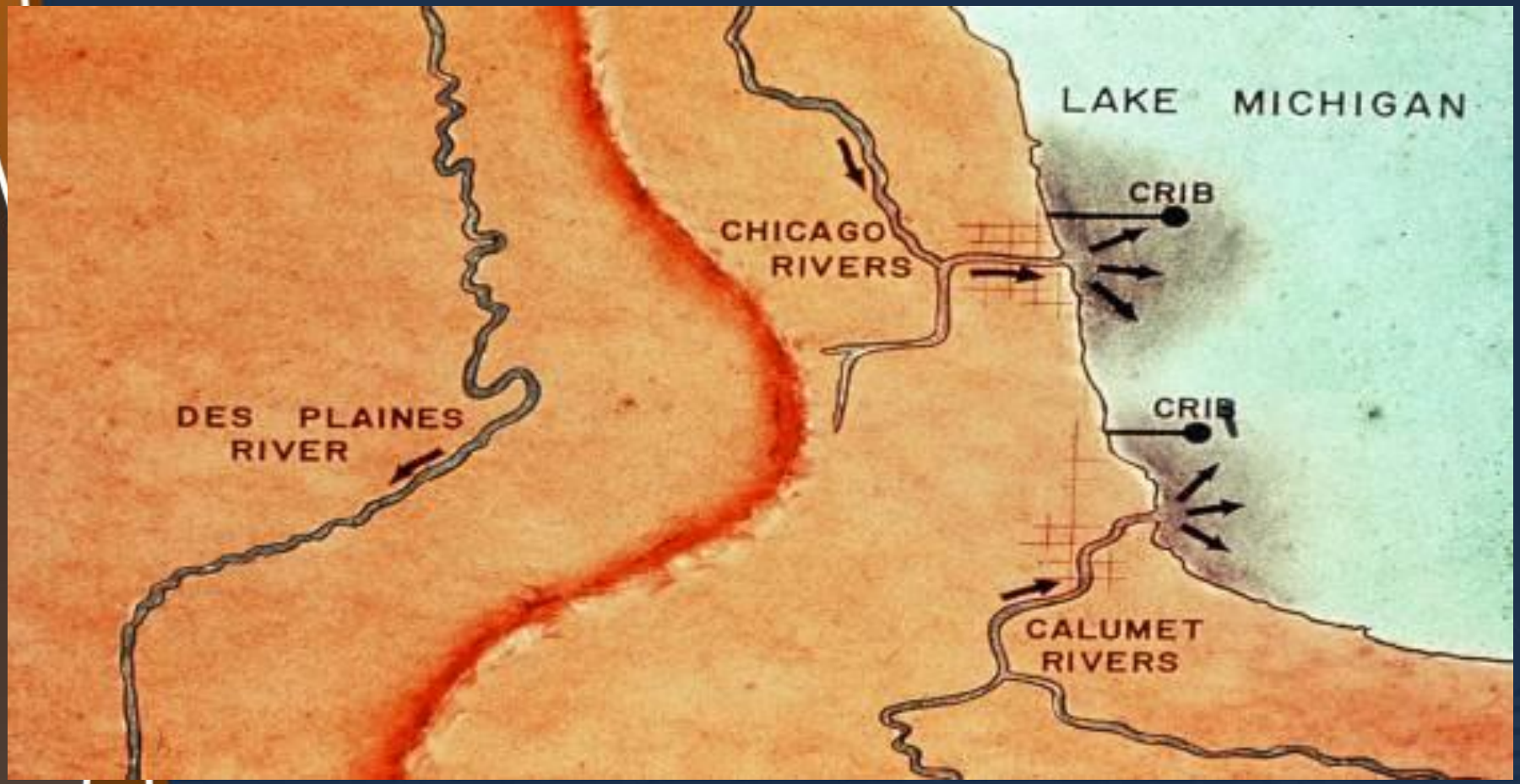
- Prevent 2-way ANS transfer
- Maintain/Enhance efficient waterway transportation
- Reduce flood risk in IL and IN
- Reduce impact of CSOs in IL and IN
- Protect/improve water quality and meet environmental regulations
- Reduce discretionary diversions from Lake MI
- Create local benefits and facilitate cost sharing

Why Chicago Area Waterway System (CAWS)?



Source: GLMRIS Report - USACE

Pre-CAWS 1860-1900



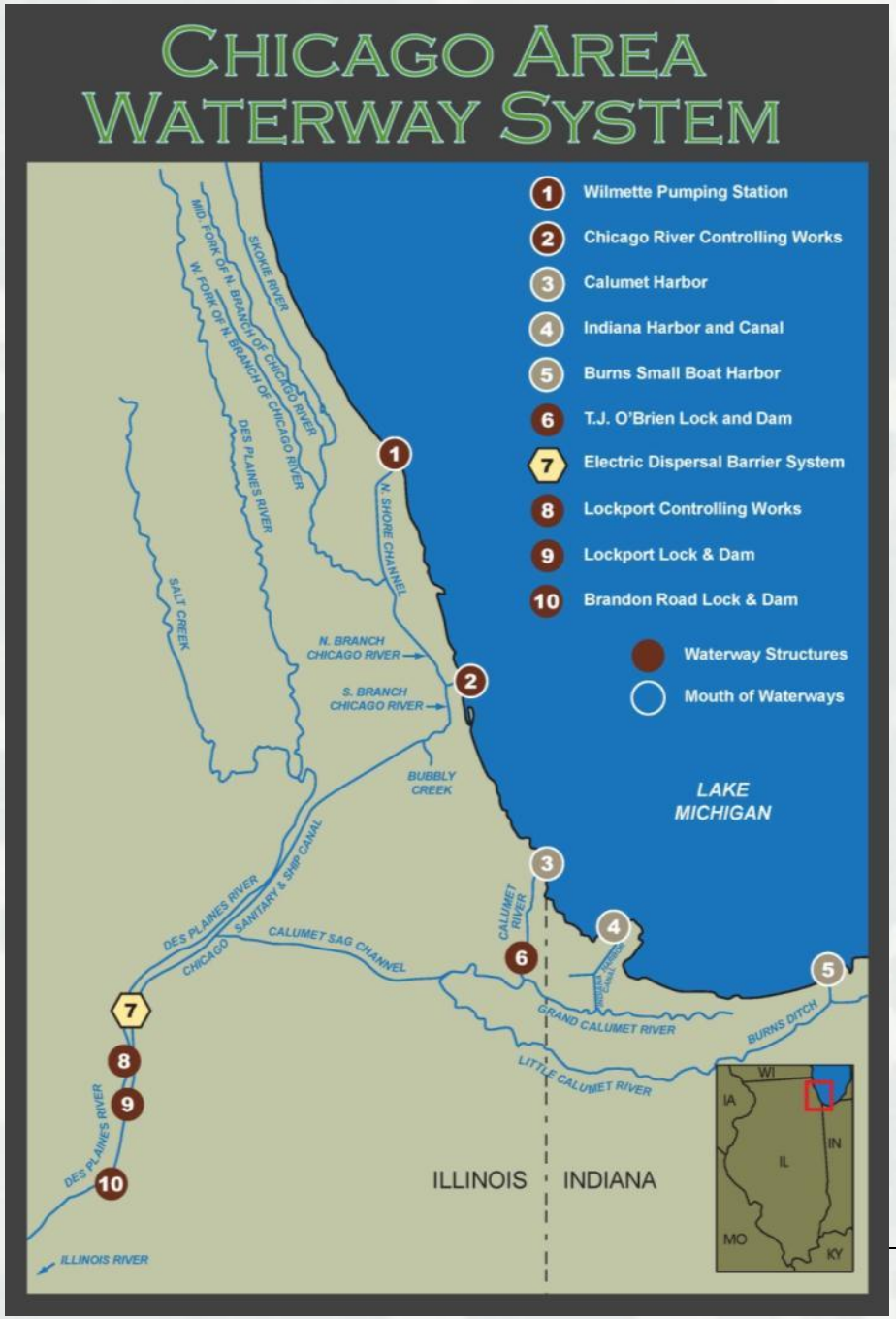
CAWS


NORTH SHORE CHANNEL
WILMETTE
LAKE MICHIGAN
CRIB
CHICAGO RIVERS
CRIB
DES PLAINES RIVER
MAIN CHANNEL
O'BRIEN LOCK
CALUMET RIVERS
CALUMET SAG CHANNEL
LOCKPORT

Water flow in the Chicago Area, circa 1900

Current water flow in the Chicago Area Waterway System

Graphics courtesy of the Great Lakes Commission

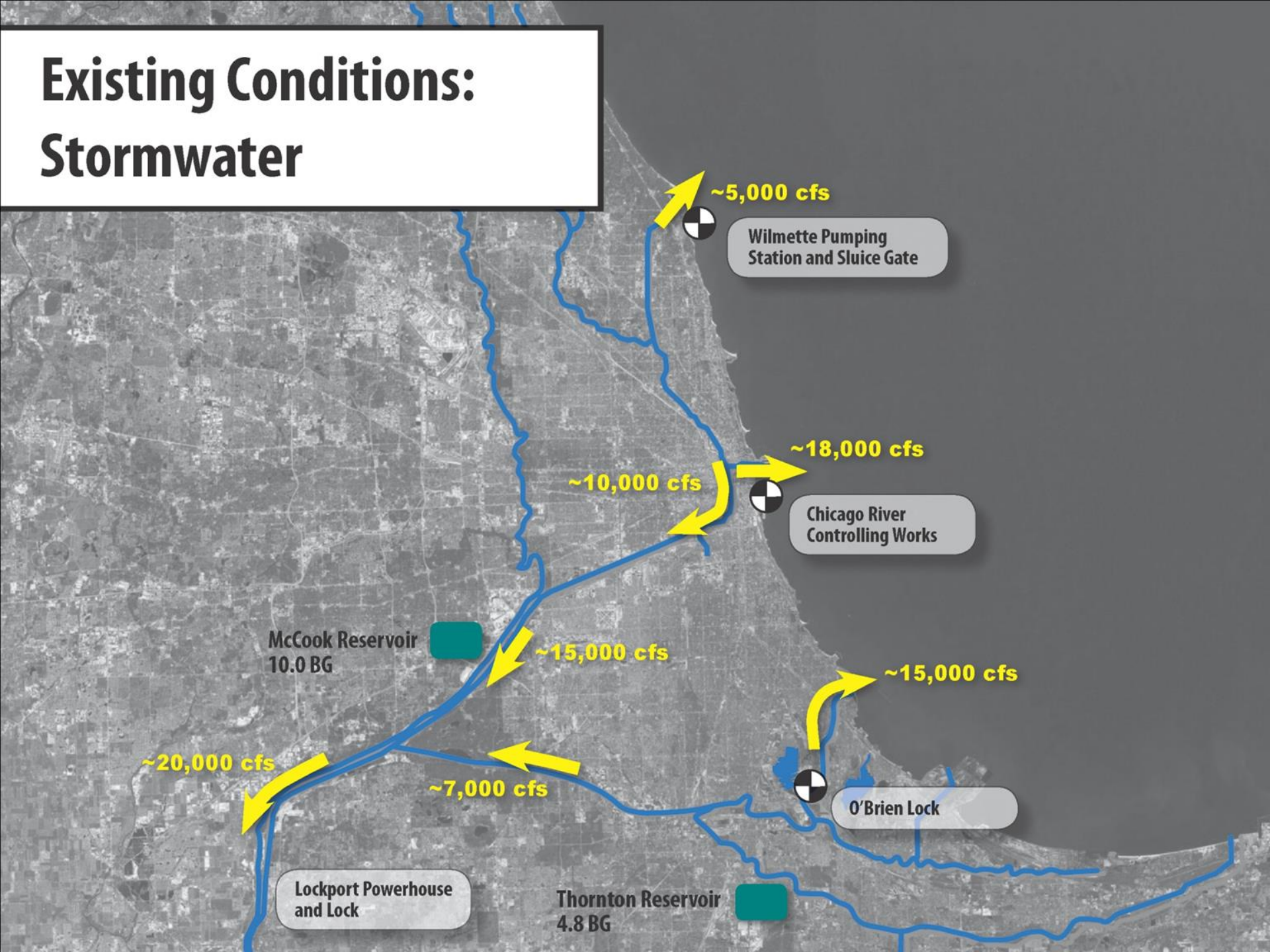


CAWS Functions

- Complex, multi-use waterway
  - Navigation
    - Cargo
    - Commercial – Passenger and Governmental (Fire, Police, etc)
    - Recreational
  - Water Supply & Conveyance
    - Municipal wastewater
    - Industrial users
  - Flood Risk Management
    - Stormwater
    - Combined sewer overflow
  - Recreation
- Primary connection between Great Lakes & Mississippi River basins

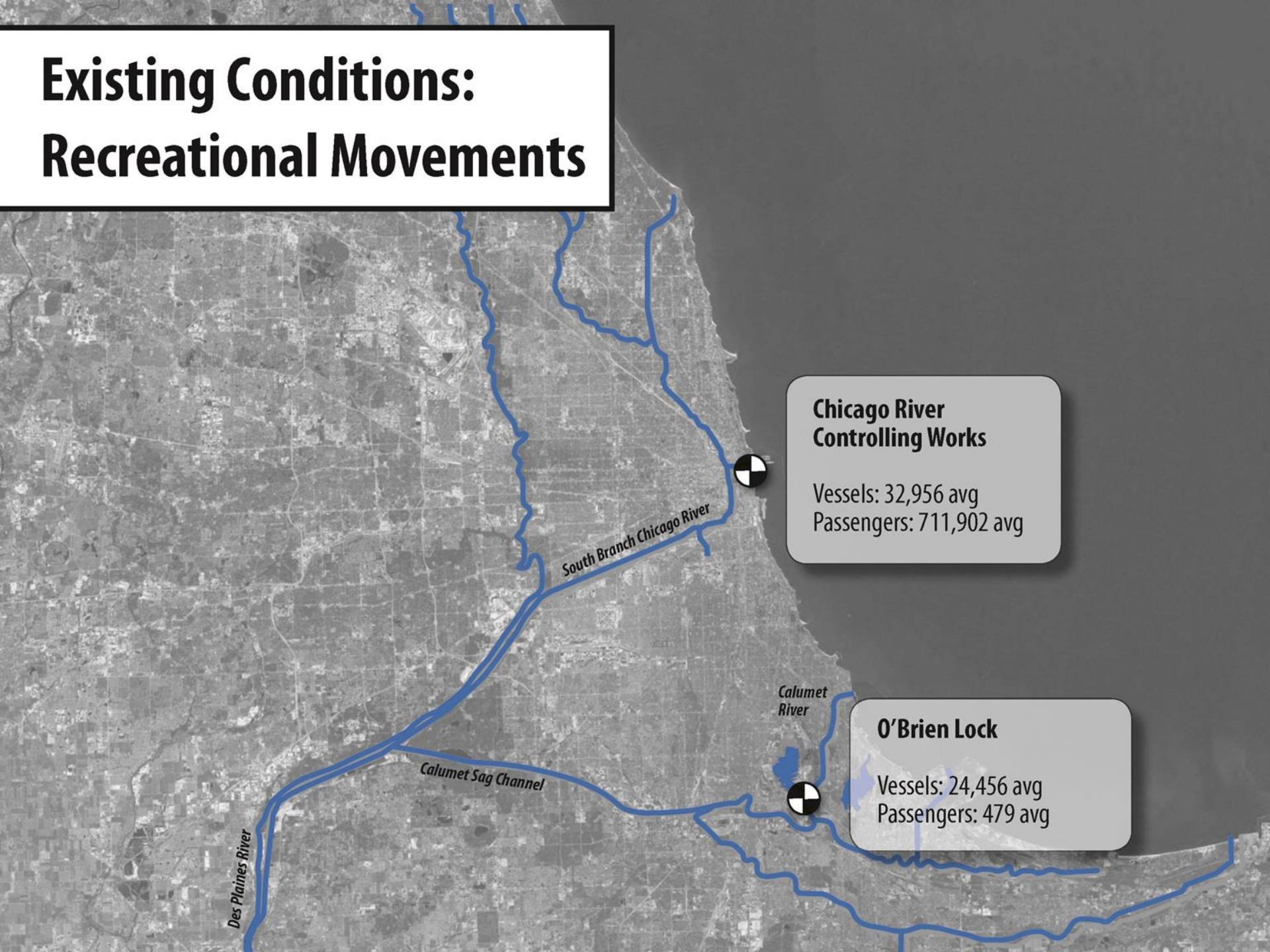
Source: GLMRIS Report - USACE

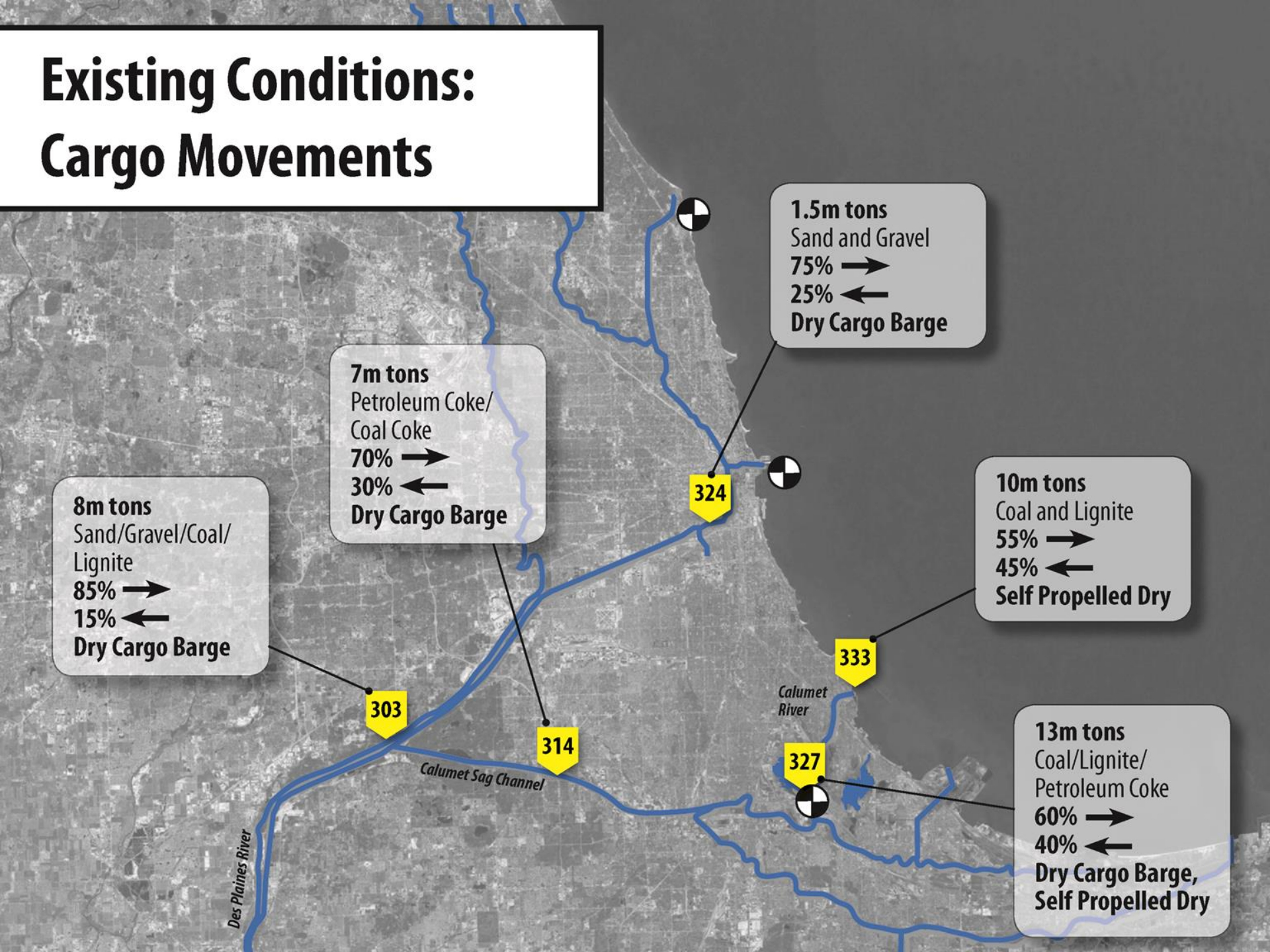
Existing Conditions: Stormwater



Existing Conditions: Water Quality

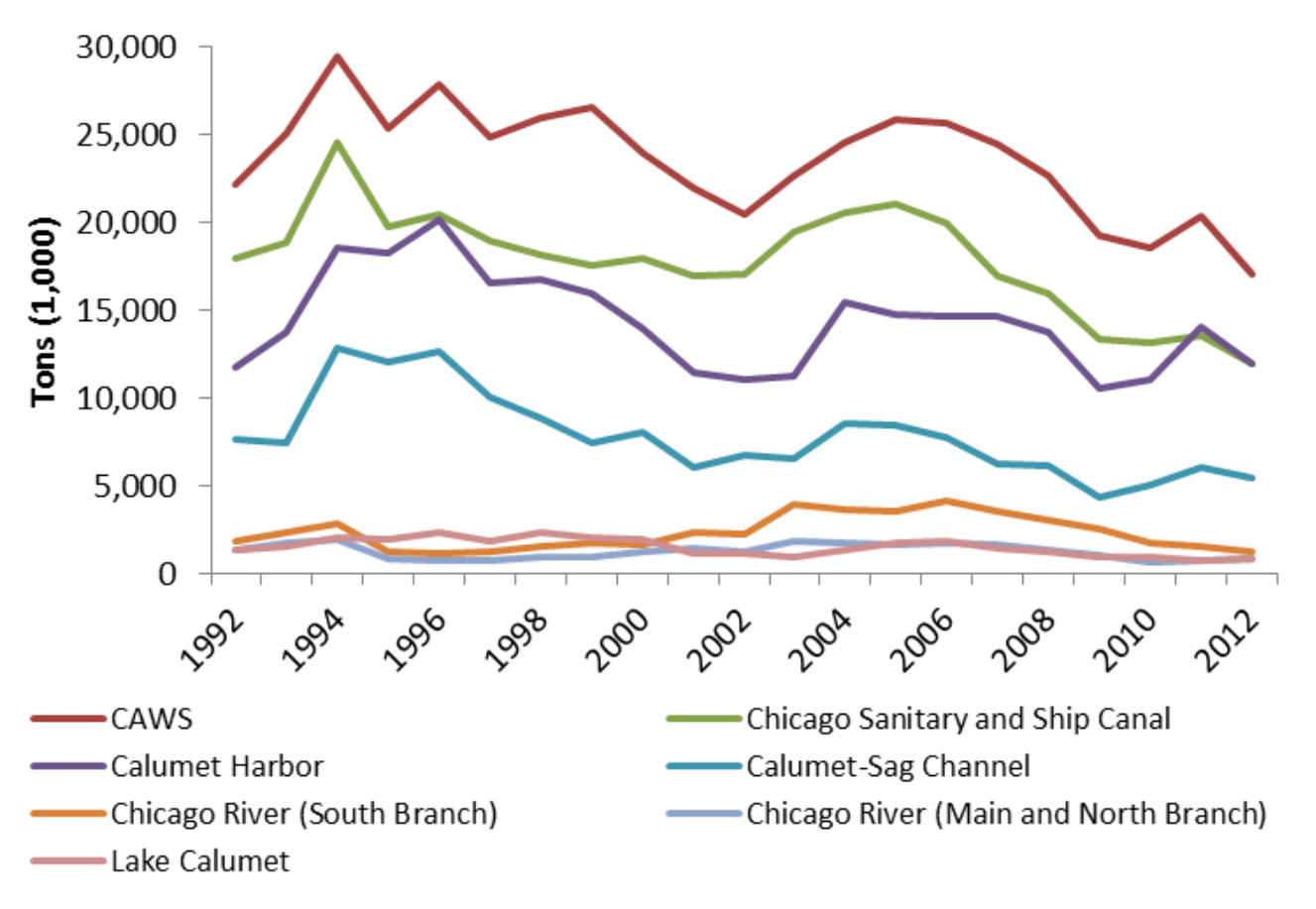
Existing Conditions: Recreational Movements




Existing Conditions:
Cargo Movements
1.5m tons
Sand and Gravel
75% →
25% ←
Dry Cargo Barge
7m tons
Petroleum Coke/
Coal Coke
70% →
30% ←
Dry Cargo Barge
8m tons
Sand/Gravel/Coal/
Lignite
85% →
15% ←
Dry Cargo Barge
10m tons
Coal and Lignite
55% →
45% ←
Self Propelled Dry
13m tons
Coal/Lignite/
Petroleum Coke
60% →
40% ←
Dry Cargo Barge,
Self Propelled Dry
324
333
303
314
327
Calumet River
Calumet Sag Channel
Des Plaines River

HISTORICAL TONNAGE FOR WATERWAY

By Segments, 1992 - 2012



Notes:
Tonnages include inbound, outbound, through, and internal traffic on each segment, as applicable (i.e. tonnage passing through the CAWS to/from Illinois River and Lake Michigan).

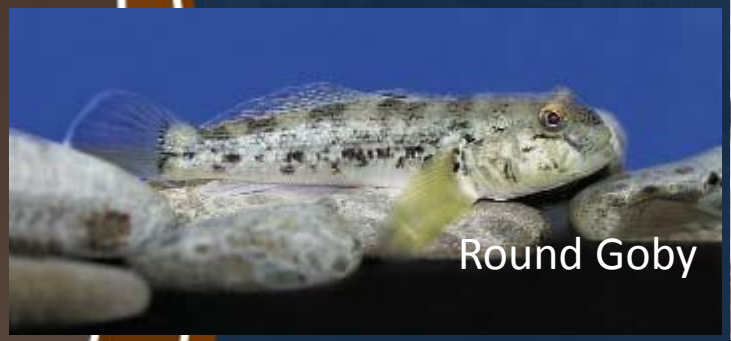
SHORT AND LONG TERM FORECASTS

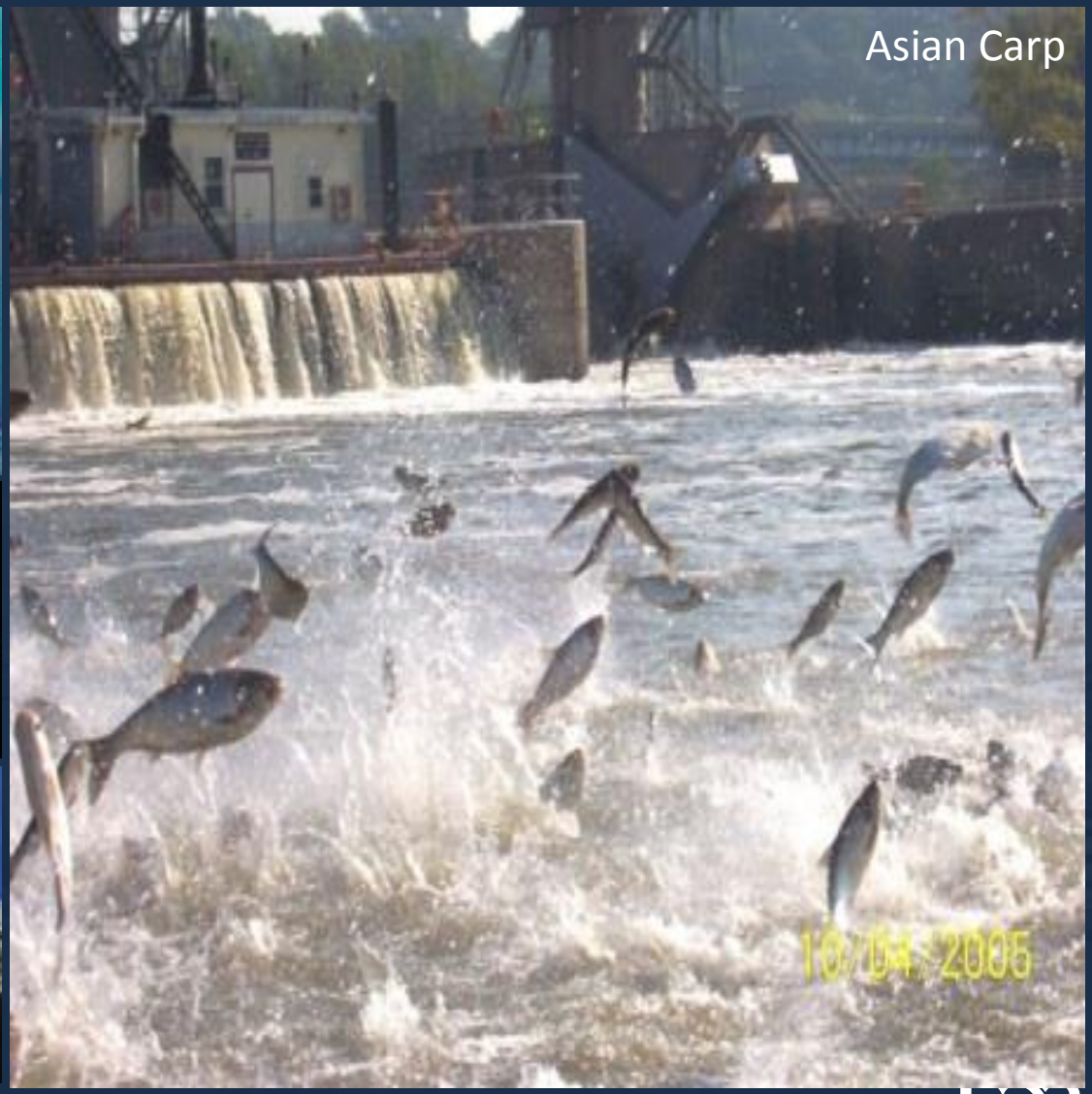
By Commodity (ktons)

Commodity	Current	2020		2040	
	2011/2012 Average	Low	High	Low	High
Coal	5,495	2,000	4,000	1,000	2,200
Petroleum	3,336	3,000	4,000	2,500	6,100
Chemicals	1,247	500	1,500	250	2,300
Crude Materials	4,881	7,000	8,200	11,500	13,500
Manufactured Goods	3,465	1,600	4,300	900	7,200
Food and Farm	262	0	1,000	0	1,800
Manufactured Equipment	24	0	200	0	200
Unknown NEC	13	0	200	0	900
Total	**18,721**	**14,100**	**23,400**	**16,150**	**34,200**

AQUATIC NUISANCE SPECIES (ANS)

What species are a risk?





Targeted Species

- Pathways ➔ **2-way Aquatic Focus**
- Categories
  - Fish
  - Plant
  - Algae
  - Crustacean
  - Virus
- Modes of movement
  - Floating
  - Swimming
  - Assisted (i.e. hitchhiking)

Diverse factors require distinct assumptions

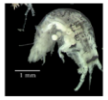
GLMRIS ANS OF CONCERN - CAWS

	T_0	T_{10}	T_{25}	T_{50}
Species Posing Risk of Adverse Impact to Great Lakes				
Scud (*Apocorophium lacustre*)	M	M	M	M
Silver carp (*Hypophthalmicthys molitrix*)	L	L	M	M
Bighead carp (*Hypophthalmicthys noblis*)	L	L	M	M
Species Posing Risk of Adverse Impact to Mississippi River				
Bloody red shrimp (*Hemimysis anomala*)	H	H	H	H
Fishhook waterflea (*Cercopagis pengoi*)	L	L	M	H
Grass kelp (*Enteromorpha flexuosa*)	L	M	M	M
Red algae (*Bangia atropurpurea*)	M	M	M	M
Diatom (*Stephanodiscus binderanus*)	M	M	M	M
Reed sweetgrass (*Glyceria maxima*)	L	L	L	M
Threespine stickleback (*Gasterosteus aculeatus*)	M	M	M	M
Tubenose goby (*Proterorhinus semilunaris*)	L	M	M	M
Ruffe (*Gymnocephalus cernuus*)	L	L	L	M
Viral Hemorrhagic Septicemia (*Novirhabdovirus* sp.)	M	M	M	M

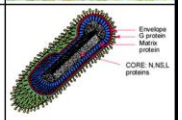
- 13 ANS of Concern
  - Rated either H, M risk at some time step
- Five categories to control
  - Fish, Plant, Algae, Crustacean, Virus

Source: GLMRIS Report - USACE

Mississippi River

Organism Type	Species	Current Location	Dispersal Mechanisms	Picture
Fish	Silver Carp (*Hypophthalmichthys molitrix*)	At the CAWS	Active swimming	
	Bighead Carp (*Hypophthalmichthyes nobilis*)	At the CAWS		
Crustacean	Scud (*Apocorophium lacustre*)	At the CAWS	Passive drift; Benthic movement; Hull fouling; Ballast water	

Great Lakes

Organism Type	Species	Current Location	Dispersal Mechanisms	Picture
Crustacean	Fishhook Water Flea (*Cercopagis pengoi*)	At the CAWS	Passive drift; Hull fouling; Ballast water	
	Bloody Red Shrimp (*Hemimysis anomala*)	At the CAWS	Passive drift; Hull fouling; Ballast water	
Algae	Grass Kelp (*Enteromorpha flexuosa*)	Muskegon Lake	Passive drift; Temporary vessel attachment	
	Red Algae (*Bangia atropurpurea*)	Uncertain, documented near Chicago	Passive drift; Temporary vessel attachment	
	Diatom (*Stephanodiscus binderanus*)	At the CAWS	Passive drift; Temporary vessel attachment	
Plant	Reed Sweetgrass (*Glyceria maxima*)	Milwaukee County, WI	Passive drift; Temporary vessel attachment	
Fish	Threespine Stickleback (*Gasterosteus aculeatus*)	Found in CAWS	Active swimming; Ballast water	
	Ruffe (*Gymnocephalus cernuus*)	Green Bay, WI	Active swimming; Ballast water	
	Tubenose Goby (*Proterorhinus semilunaris*)	Duluth-Superior Harbor	Active swimming; Ballast water	
Virus	Viral Hemorrhagic Septicemia - VHSv (*Novirhabdovirus sp*)	All Great Lakes: Lake Michigan-Waukegan and Winthrop Harbors	Viral disease of freshwater and marine fish; transported through: infected fish, eggs, or water	

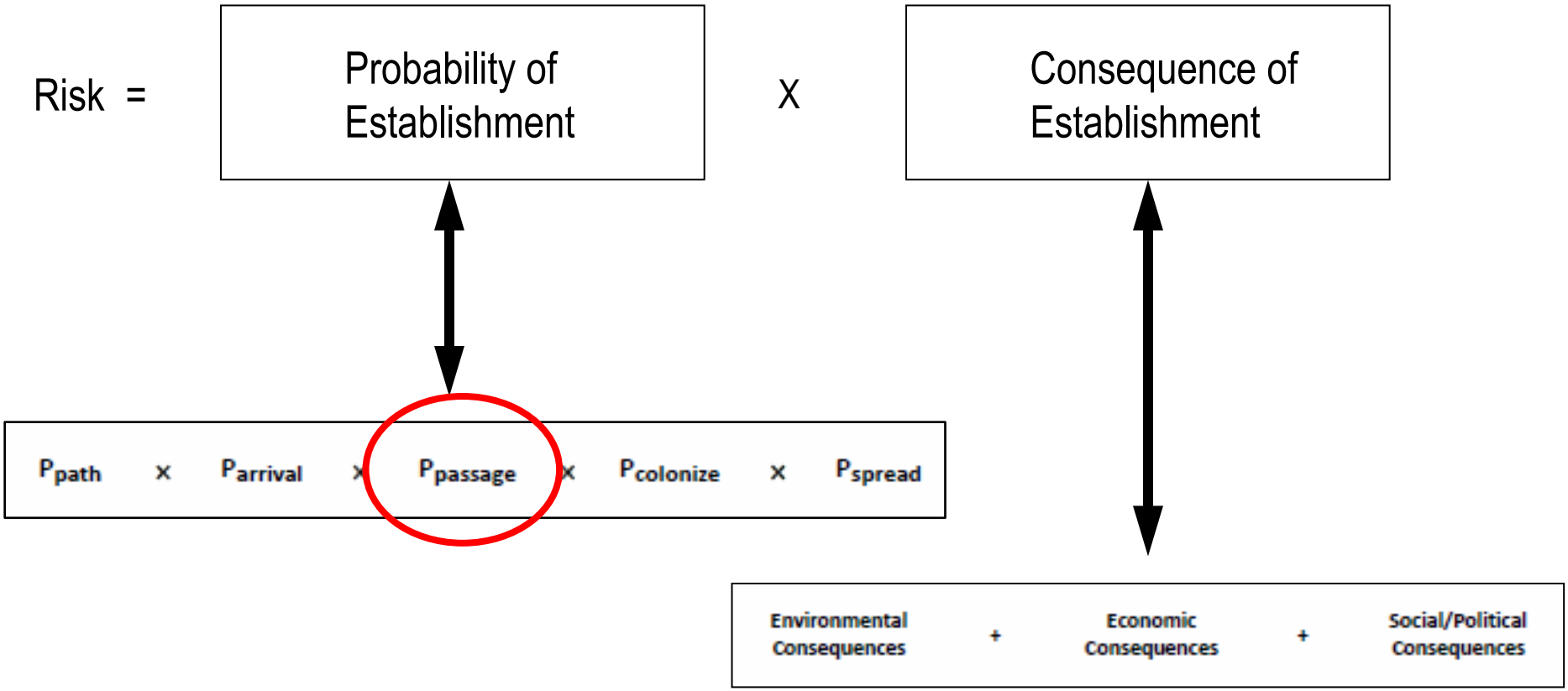
DISPERSAL AND ANS SPECIES

- Dispersal
  - **Active:** movement by its own means (e.g., swimming)
  - **Passive:** movement by other means, such as water flow, boats, or another object (e.g., floating or hitchhiking)
- ANS Species
  - Primarily 13 species from GLMRIS
  - Consideration of additional species in future
- Aquatic Pathway Focus
  - Other means of transfer – human, bird/terrestial

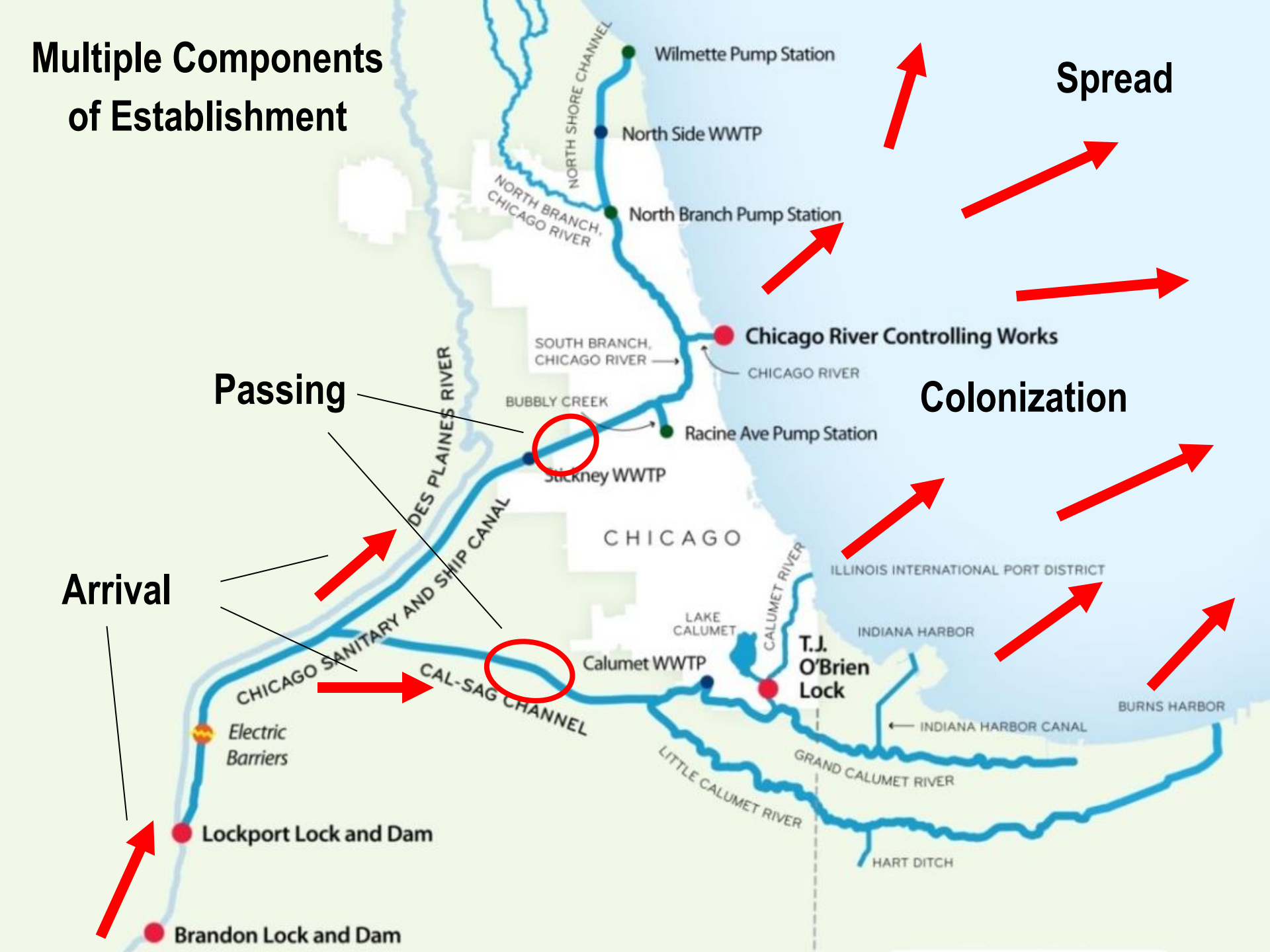
POTENTIAL IMPACTS AND RISK

- Environmental – consequences to ecosystem/habitat and native species
- Economic –already transferred ANS estimated to cost $10s M to $100s M+ annually per species (sea lamprey/zebra mussels)
- Social/Political – potential effects on recreation and/or regulatory requirements

GLMRIS Risk Assessment

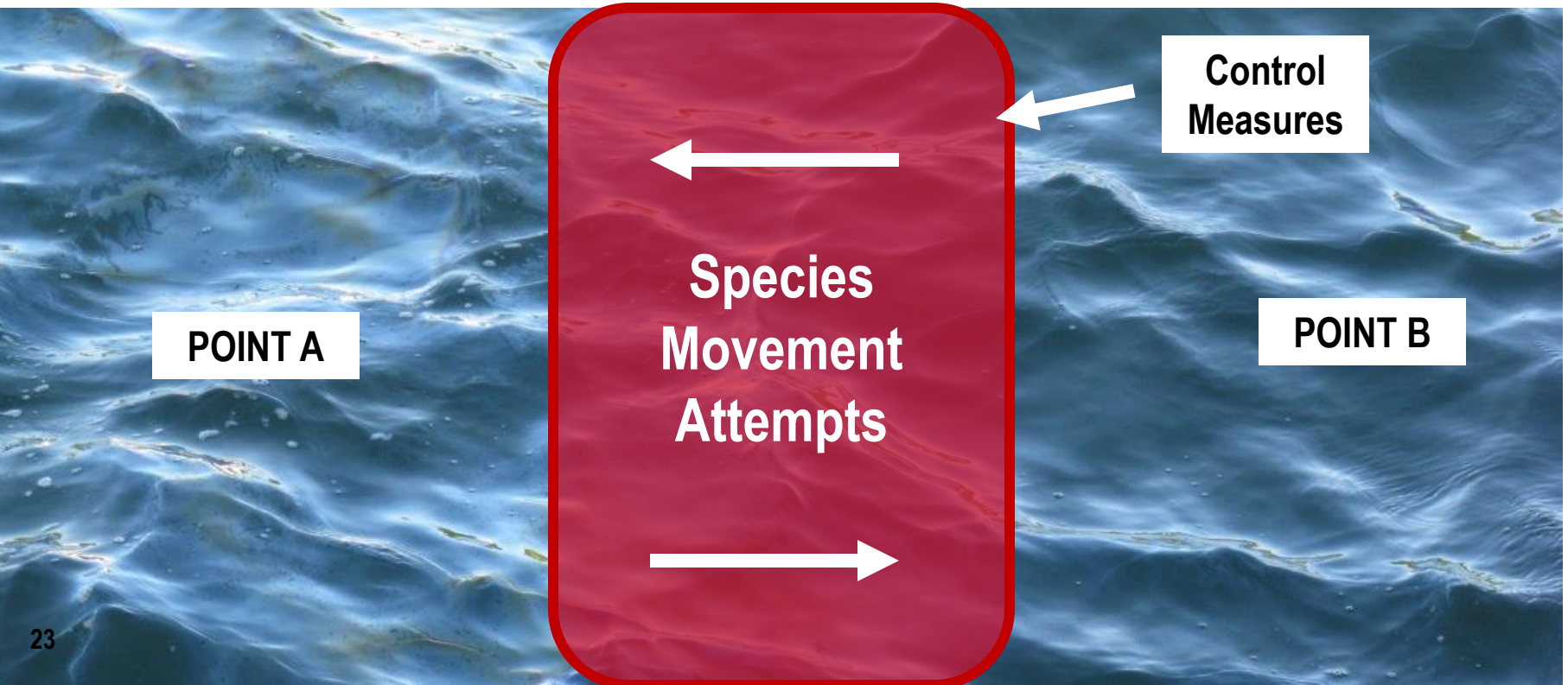


Source: GLMRIS Report - USACE


Multiple Components of Establishment
Spread
Passing
Colonization
Arrival
Wilmette Pump Station
North Side WWTP
North Branch Pump Station
NORTH SHORE CHANNEL
NORTH BRANCH, CHICAGO RIVER
Chicago River Controlling Works
SOUTH BRANCH, CHICAGO RIVER
CHICAGO RIVER
BUBBLY CREEK
Racine Ave Pump Station
Stickney WWTP
DES PLAINES RIVER
CHICAGO SANITARY AND SHIP CANAL
CHICAGO
CAL-SAG CHANNEL
Calumet WWTP
LAKE CALUMET
CALUMET RIVER
T.J. O'Brien Lock
ILLINOIS INTERNATIONAL PORT DISTRICT
INDIANA HARBOR
INDIANA HARBOR CANAL
BURNS HARBOR
GRAND CALUMET RIVER
LITTLE CALUMET RIVER
HART DITCH
Electric Barriers
Lockport Lock and Dam
Brandon Lock and Dam

PASSAGE REDUCTION EFFICIENCY

- Preventing dispersal from Point A to Point B
- Baseline (0% efficiency) = 'open river' with no control measures
- Relative to movement at a single point, not probability of establishment

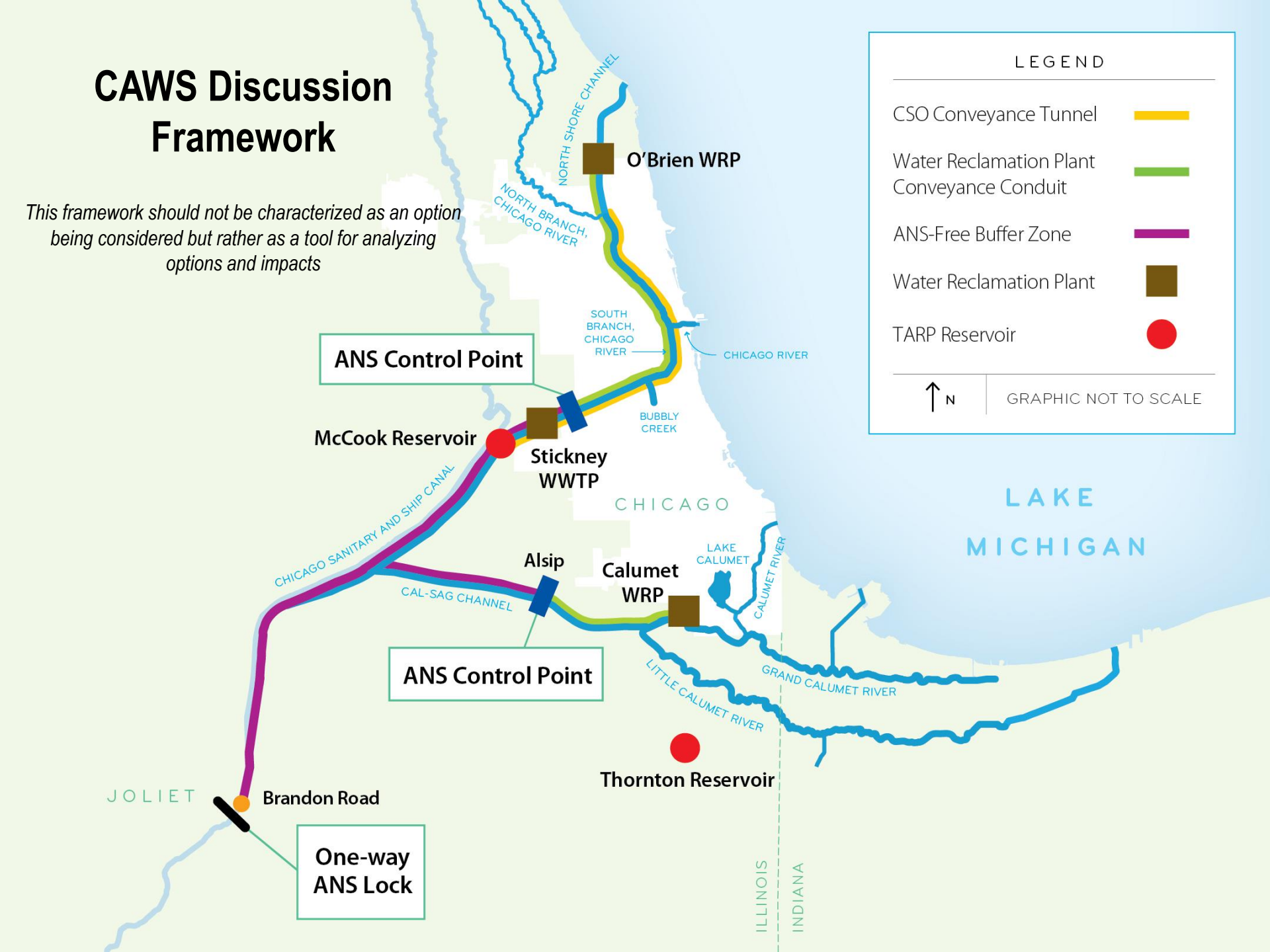


CURRENT ANS RISK REDUCTION EFFORTS

- Electric Dispersal Barrier Operations and Enhancements - USACE
- Brandon Road ANS Lock Investigation – USACE
- Research on CO_2 and water guns (Asian carp) – USGS
- Commercial fishing (Asian carp) in IL Waterway – IDNR
- Monitoring/inspection/outreach – multiple states

CAWS Discussion Framework

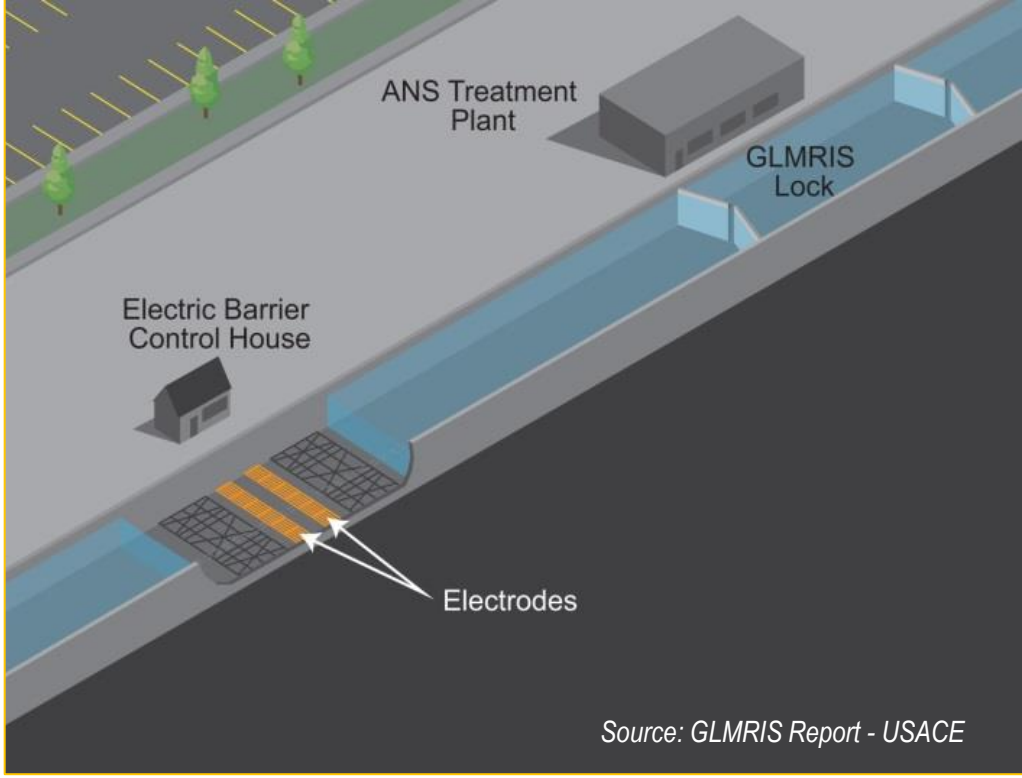
This framework should not be characterized as an option being considered but rather as a tool for analyzing options and impacts



ANS Lock System

- Control Technologies
  - Flushing lock
  - Electric barrier
  - Water treatment (CO2, UV, Chlorine, etc.)
- Species
  - Varies w/ controls
  - Typ. swimmers & floaters
- Maritime transportation
  - Implications vary w/ controls
  - Additional investigations needed

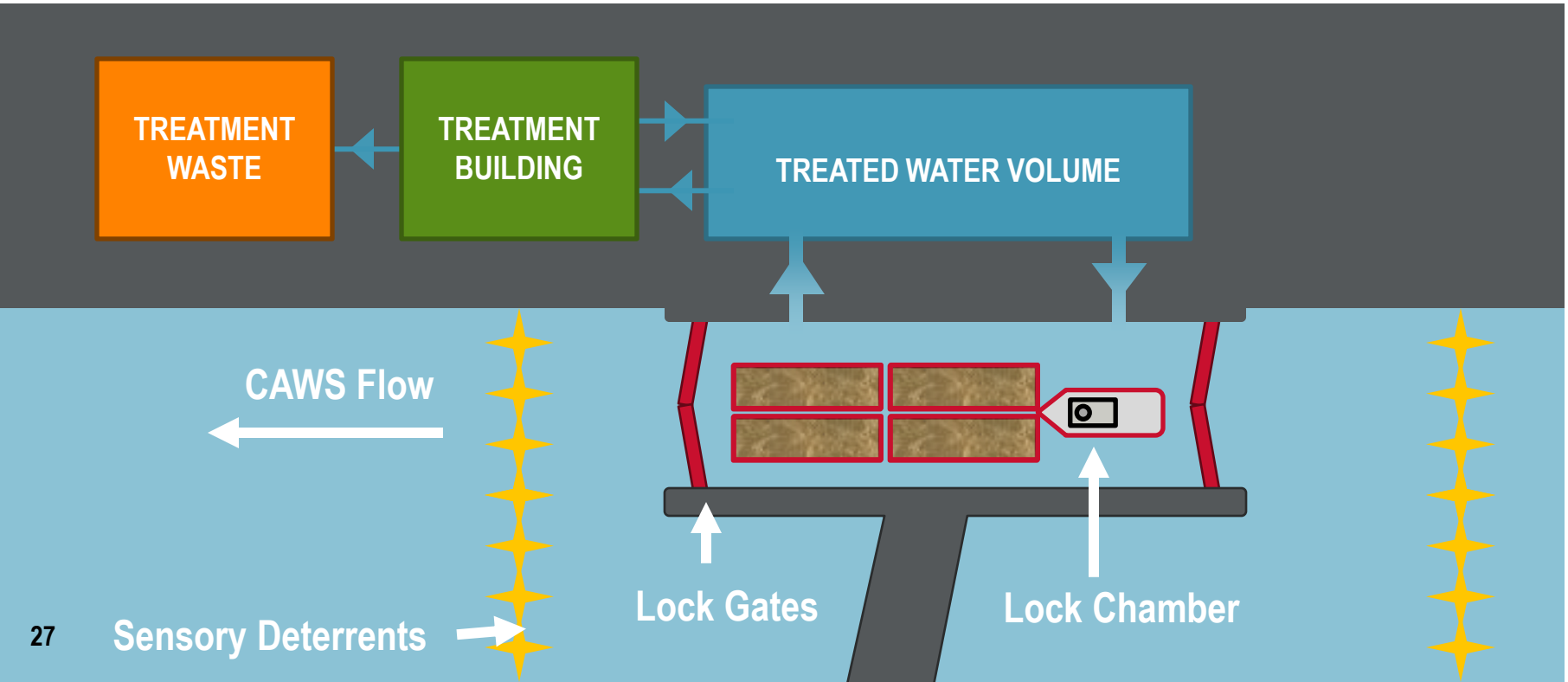
System has Numerous Controls - Varies by Location



Sample ANS Lock System Configuration

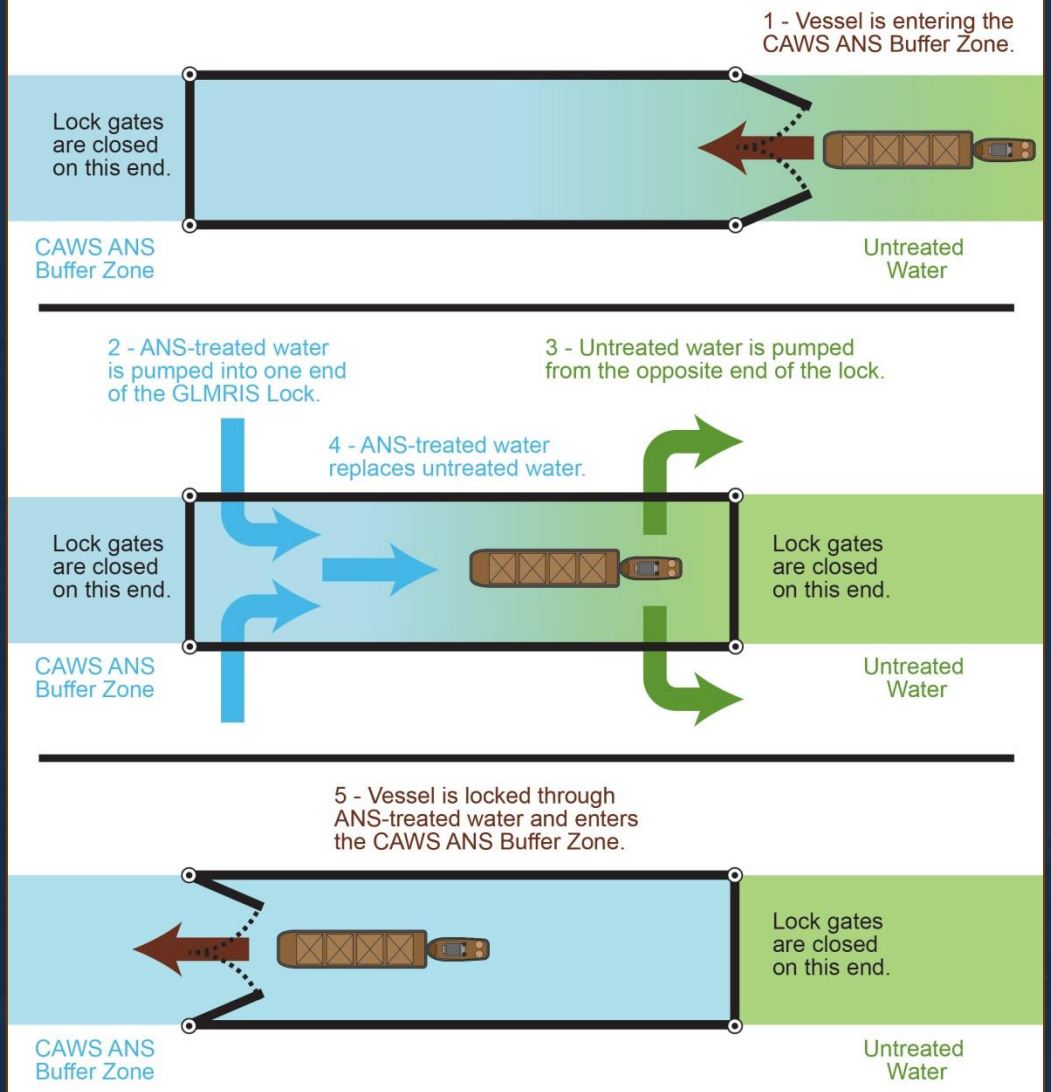
ANS LOCK SYSTEM

- ANS lock system is a combination of control measures
- Contains physical, chemical and biological measures used in arrangement designed to increase efficiency.
- Estimated to provide >75% reduction in species movement through a specific point of control.



GLMRIS Lock

Prevents the transfer of ANS that move by Passive Draft along the current of water.

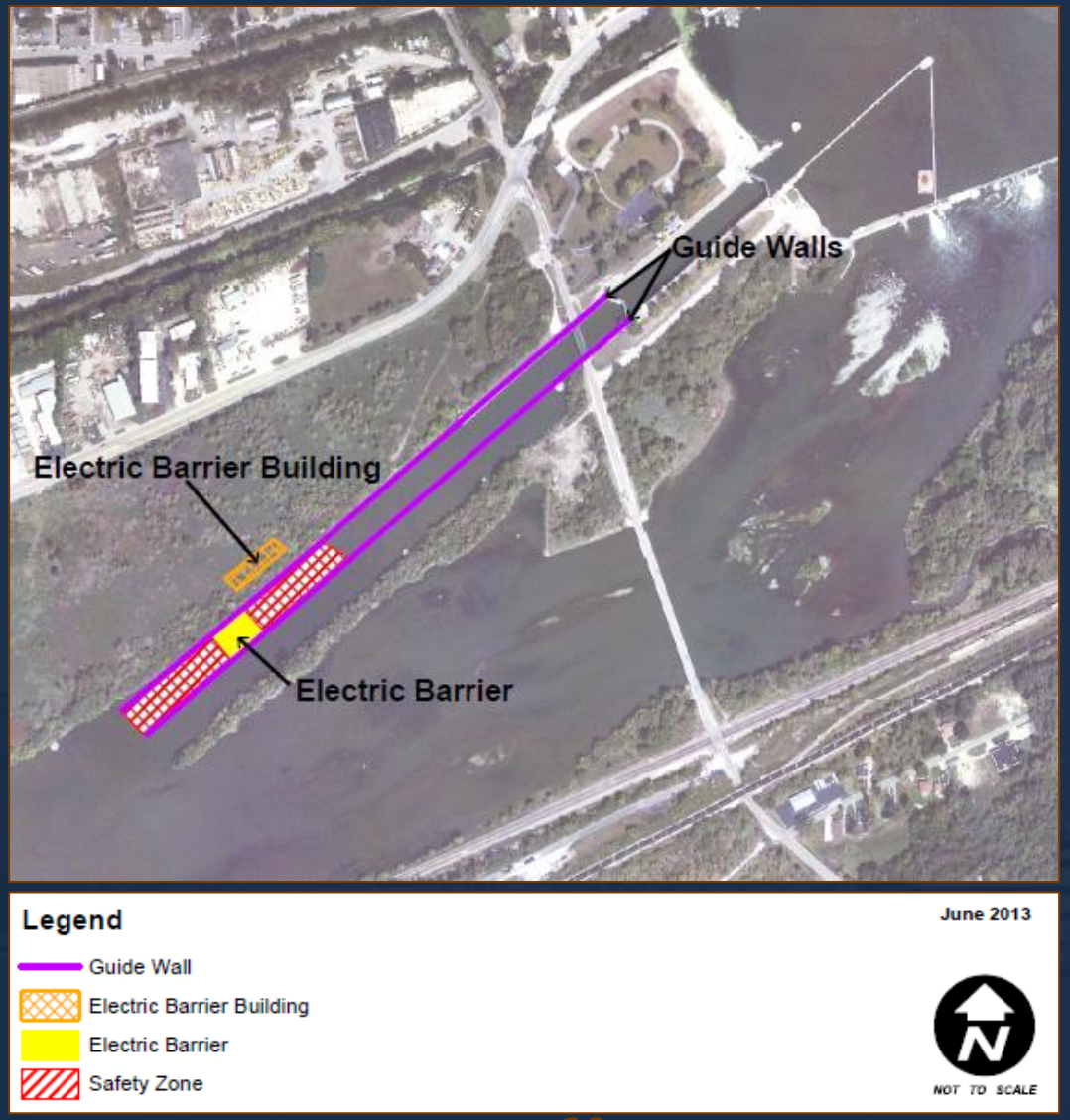


*General operating conditions are shown. Operations would vary based on direction of travel and site specific conditions.

Source: GLMRIS Report - USACE

Conceptual ANS Lock System at Brandon Lock

- Control Technologies
  - 1-way Flushing lock
  - Electric barrier
- Species
  - Swimmers
  - Floaters
  - No Lake MI species
- Maritime transportation
  - Fill/travel times
  - Stray currents
  - Operator/vessel safety



Source: GLMRIS Report - USACE

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ANS Buffer Zone

- 2-way species control
- Minimize impacts to users/uses
- Upstream/downstream control
- Combination of 1-way and 2-way control points
- Various technologies
- Miss River and Lake MI species
- Phased implementation

Buffer Zone Concept
(example for illustrative purposes only)

System has Numerous Controls – Varies by Location

Source: GLMRIS Report - USACE

Maritime Transportation

- Potential Implications (depending upon type of control point)
  - Travel/lockage times and delays
  - Passenger/operator safety
  - Shipping rates and other costs
  - Other
- Influencing Assumptions
  - Holding/contact times
  - Water volumes/rates
  - Structure/vessel integrity
  - Other

What controls will maintain efficient maritime transportation?

RELATING PASSING EFFICIENCY TO RISK REDUCTION

CONTROL MEASURES BY SPECIES

- Qualitative Relative Rating – Numerical & Color
  - Dark Green (3A) – highest
  - Green (3B) – medium
  - Light Green (3C) - lowest

95%	95% or greater efficient preventing movement - low uncertainty
85%	85%-95% efficient preventing movement - medium uncertainty
75%	75%-85% efficient preventing movement - high uncertainty

Levels of Uncertainty Outlined in GLMRIS

- **High** = Little or no data were available, or there was a very broad range in the nature and severity of consequences including extreme consequences, and the probability or consequence ratings (as well as all assumptions used to develop the ratings) were based on professional judgment;
- **Medium** = Good data were available but some major data gaps were still evident, or there was a broad range in the nature and severity of the consequences but no extreme consequences were indicated, such that the probability or consequence rating is based on a mixture of ANS-specific data, data from similar species, anecdotal data, and professional judgment;
- **Low** = Good ANS-specific data were available (e.g., peer-reviewed, ANS specific scientific publications and reports), and no significant data gaps were known, and there was only a limited range of possible consequences; and
- **None** = Adequate data were available to fully support the probability and consequence ratings.

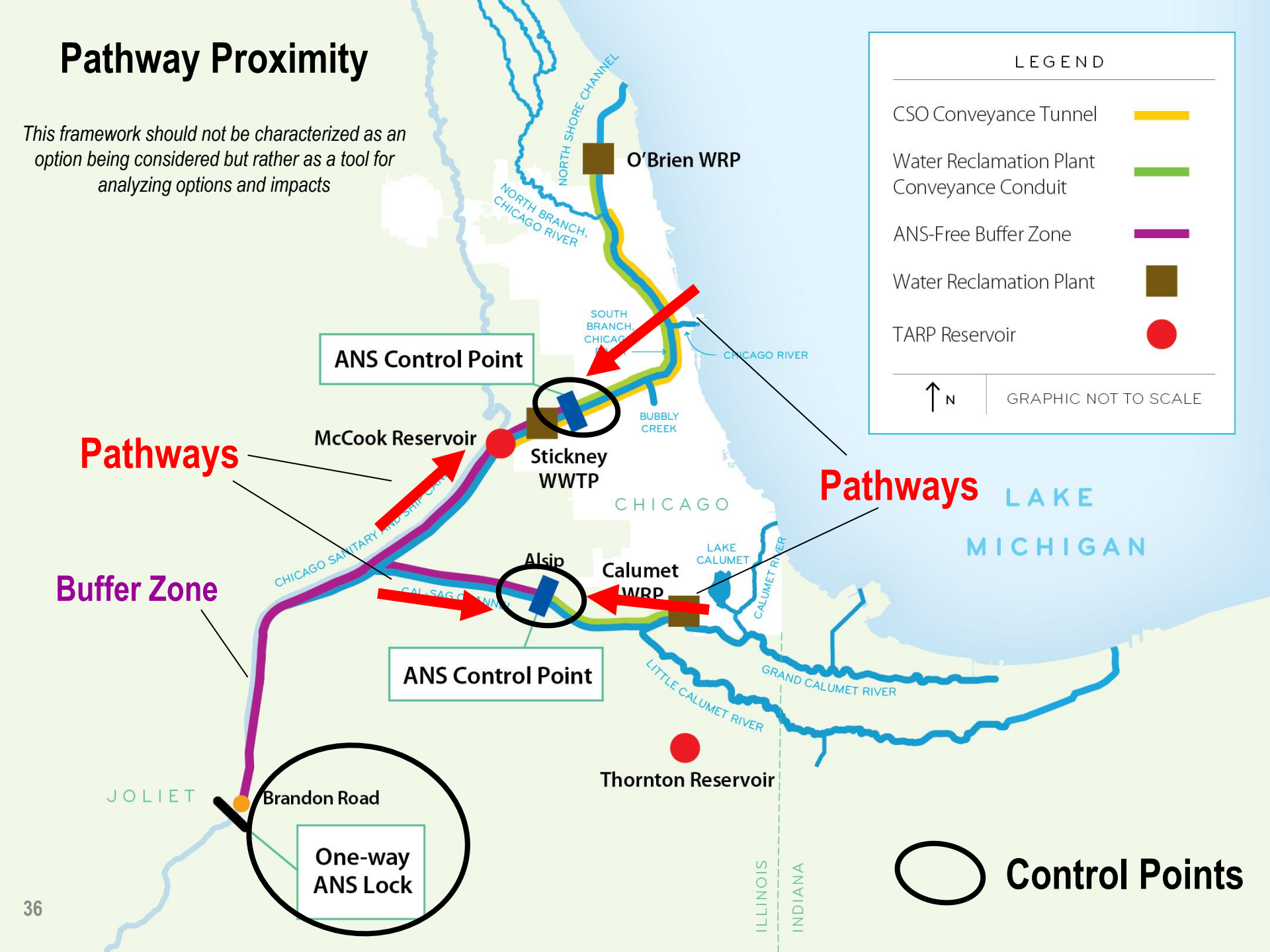
Source: GLMRIS Report - USACE

CONTROL MEASURE COMBINATIONS BY SPECIES

Control Measure Combination	Description	Estimated Passage Reduction Efficiency												
		Active Dispersal					Active/Passive			Passive Dispersal				
		Fish					Crustaceans			Plants	Algae			Disease
		Silver Carp	Bighead Carp	Ruffe	Threespine Stickleback	Tubenose Goby	Scud	Bloody Red Shrimp	Fishhook Waterflea	Reed Sweetgrass	Red Algae	Diatom	Grass Kelp	VHSv
		T_{25}	T_{25}	T_{50}	T_0	T_{10}	T_0	T_0	T_{25}	T_{50}	T_0	T_0	T_{10}	T_0
ANS Lock System Combination 1	Physical - screening Chemical - general chemicals Biological - electric deterrent	85%	85%	85%	85%	85%	75%	75%	75%	85%	75%	75%	85%	75%
ANS Lock System Combination 2	Physical - lethal temperature Chemical - none Biological - electric deterrent	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%	85%
ANS Lock System Combination 3	Physical - screening & ultraviolet light Chemical - alteration of water quality Biological - electric deterrent	85%	85%	85%	85%	85%	75%	75%	75%	75%	75%	75%	75%	85%
Physical Barrier	Physical - physical barrier Chemical - none Biological - none	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%

Pathway Proximity

This framework should not be characterized as an option being considered but rather as a tool for analyzing options and impacts



EXAMPLE OF REDUCTION IN PASSING PROBABILITY

ANS Controls Passage Reduction Efficiency	Probability of Passing		Risk Reduction Factor[1]
	Baseline	With ANS Controls	
75%	100%	25%	4
85%	100%	15%	7
95%	100%	5%	20

Notes:

1. Assumes all other probability elements are held constant

EXAMPLE OF PASSING PROBABILITY IMPACTS ON *PROBABILITY OF ESTABLISHMENT*

ANS Control	Example Species	Probability Element					Change in Passage Probability	Risk Reduction Factor
		Pathway	Arrival	Passage	Colonization	Spread		
No control	N/A	100%	80%	100%	50%	50%	N/A	N/A
ANS Lock @ 75% Efficient	Scud	100%	80%	25%	50%	50%	100% to 25%	4 (100% vs 25%)
ANS Lock @ 85% Efficient	Grass Kelp	100%	80%	15%	50%	50%	100% to 15%	7 (100% vs 15%)
ANS Lock @ 95% Efficient	TBD	100%	80%	<5%	50%	50%	100% to <5%	>20 (100% vs <5%)
Physical Barrier	All	100%	80%	<5%	50%	50%	100% to <5%	>20 (100% vs <5%)

$$P_{path} \times P_{arrival} \times P_{passage} \times P_{colonize} \times P_{spread}$$

Notes:

1. Assumes all other probability elements are held constant
2. Arrival and Passage are only elements GLMRIS alternatives are expected to impact (pathway, colonization, and spread are all independent)

PASSAGE REDUCTION FINDINGS

- ANS Lock System combinations > 75% efficient
  - Efficiency varies by species and technology
    - Higher for fish species w/ chemicals than most plant species
    - Higher for lethal temperature for plant species than chemical
  - Current information suggests lethal temperature provides highest efficiency across all species
  - Uncertainty and/or ongoing development basis for range in efficiencies
- Physical Barrier > 95% efficient
- Discussion Framework
  - Ratings based on pathway with lowest reduction efficiency
  - > 85% efficient passage reduction for Great Lakes to Mississippi species – Brandon Road 1-way
  - > 95% efficient passage reduction for Mississippi to Great Lakes species – cumulative effects

FINDINGS

- Refine ANS control measure evaluation by species
  - Potential for > 85% efficiency or RRF ~ 7 for GLMRIS species
  - Potential for > 95% efficiency or RRF ~ 20 for Mississippi to Great Lakes species – based on cumulative effects
  - Combination with Brandon Road drives cumulative effects
- Frame more fully in context of GLMRIS Risk Assessment
  - Probability of passage ➔ Probability of Establishment ➔ Risk Reduction
  - Several species may establish at any time (T0)
- Enhance risk reduction comparison for long term strategy
  - Weakest pathway link drives overall assessment
  - Further R&D and adaptive management is expected to improve efficiencies and reduce uncertainty

ADDITIONAL ANS LOCK SYSTEM EVALUATIONS

- Focused set of control measures and combinations
- Interactions of control measures working in combination
- Reduce uncertainty
  - Mixing effects in lock chamber
  - Temperature/chemical applications in lock chamber
  - Range of species
- Adaptive Management
  - Efficacy studies – lab and field
  - Demonstration projects
  - Continued refinements

DISCUSSION