Conceptual Design:
Lock Treatment System
to prevent movement of AIS through the Chicago Area Waterways System

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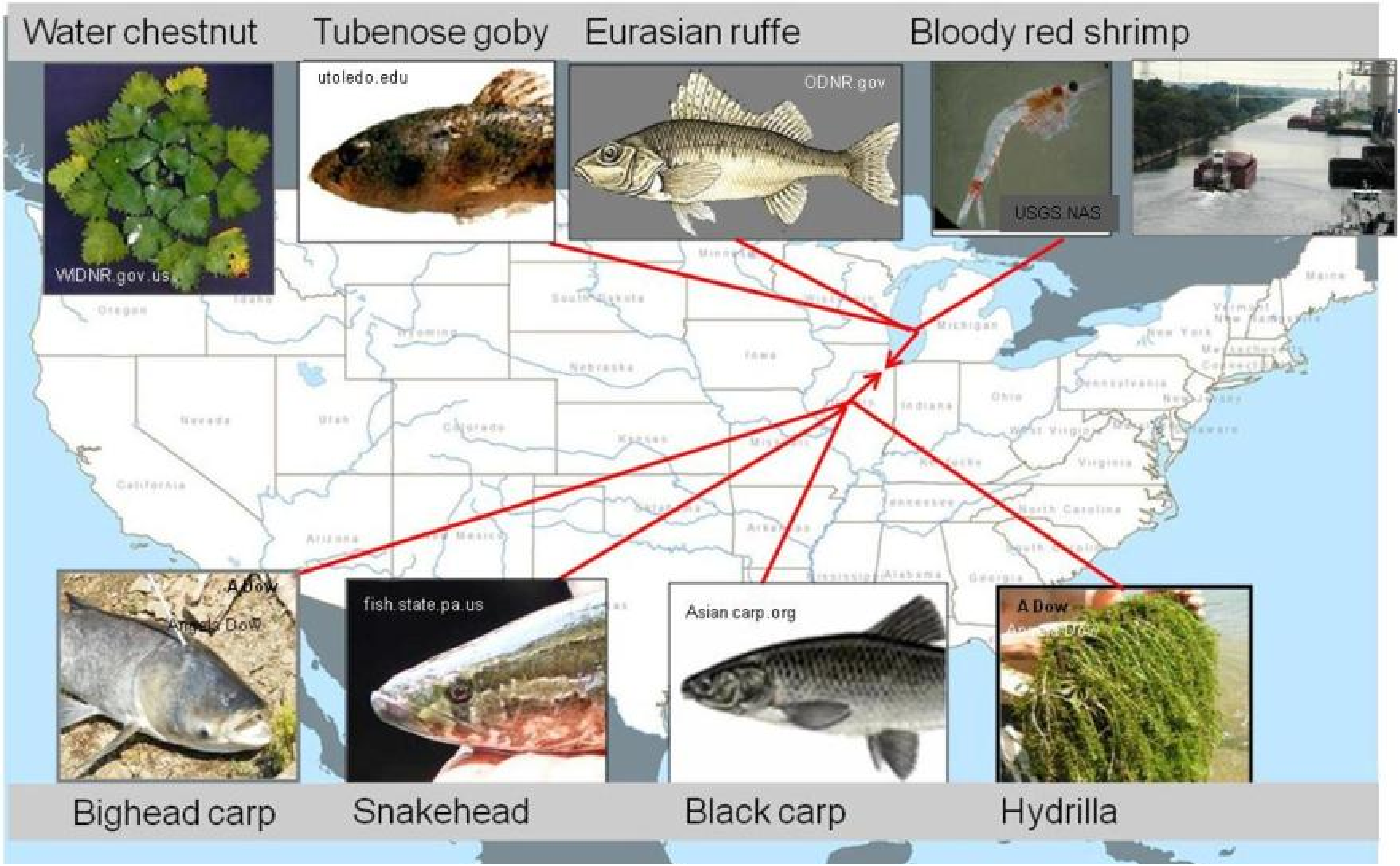
29 species currently poised to invade Mississippi River via canal



10 species currently poised to invade Great Lakes via canal

Objective of USGS study:

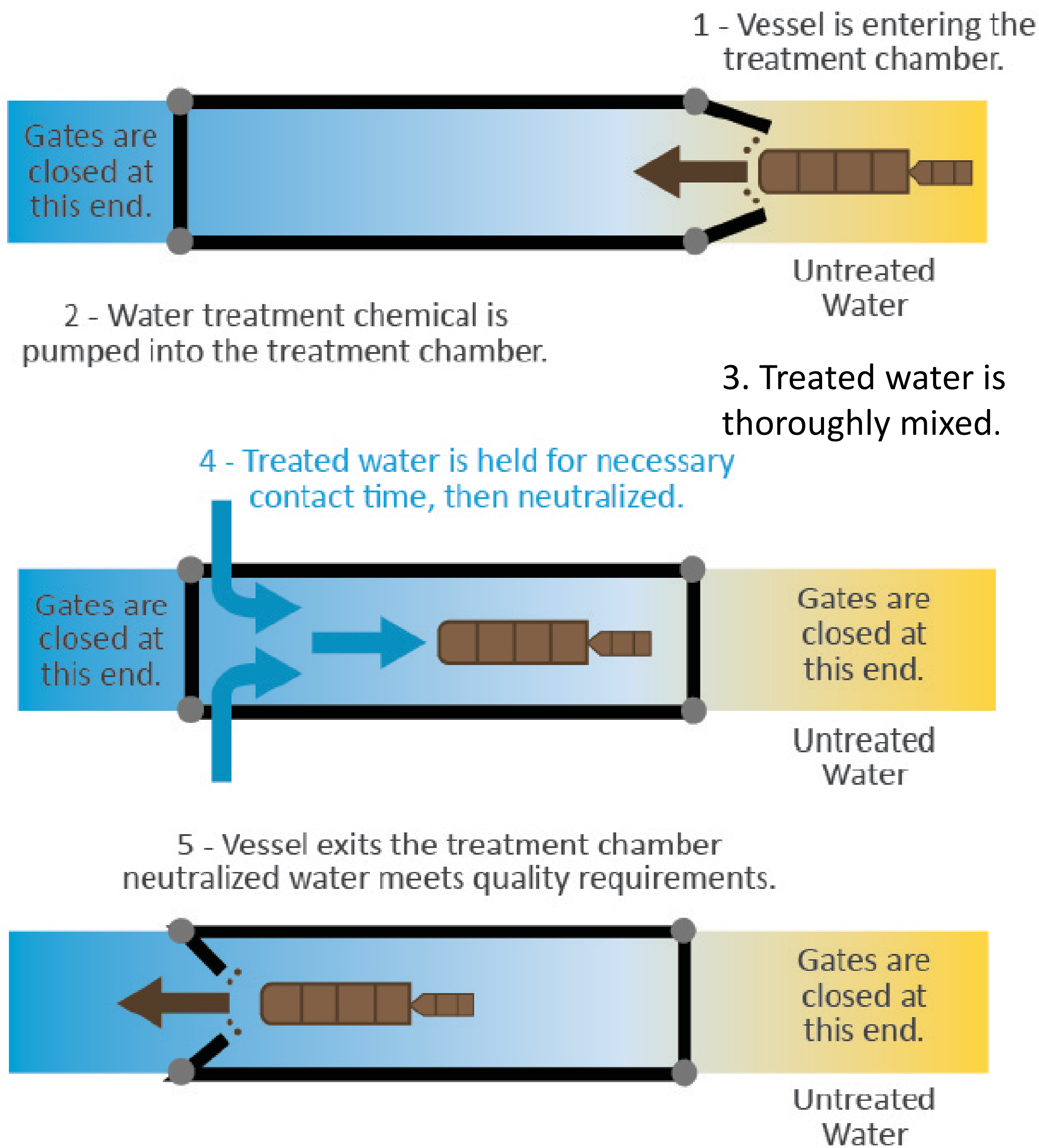
- Identify treatment options (eg. biocides, heat, and salinity) that offer the best potential to effectively kill 100% of organisms entering the lock structure in the water column or attached to hulls.
- Potential treatment options should ideally be capable of killing a full range of aquatic taxonomic groups (invertebrates, fish, and plants) across all life stages.
- Treatment would be used in combination with other methods to exclude species from the approach channel and locks.
- Treatment would not unduly impede barge and boat traffic.

Conclusion: chlorine, 43º C water, ozone and menadione

Concept used in CH2M study:

The Brandon Road Lock could be managed in a manner that would prevent upstream movement of AIS. Boats and barges moving upstream would pass through an engineered channel with a combination of deterrent measures to limit the number of fish and other mobile taxa entering Brandon Road lock with the vessels. Once the vessels enter the treatment chamber, the gates are closed. The chamber water would be chemically treated to kill all AIS to prevent their movement upstream. After treatment, the chamber will be detoxified, then the vessels allowed to enter the lock at low level. Once at the level of the CAWS, the lock gates are opened and the vessels released into the CAWS for passage upstream. An alternative is to treat in the lock chamber.

AIS Treatment Chamber Concept



Potential Treatment Chamber at Brandon Road Lock

Why was Chlorine selected?

- Rapidly lethal to a wide range of aquatic taxonomic groups (invertebrates, fish, and plants) and life stages
- Highly effective
- Widely used
- Safely used

Chlorine will react with organic matter in the water first

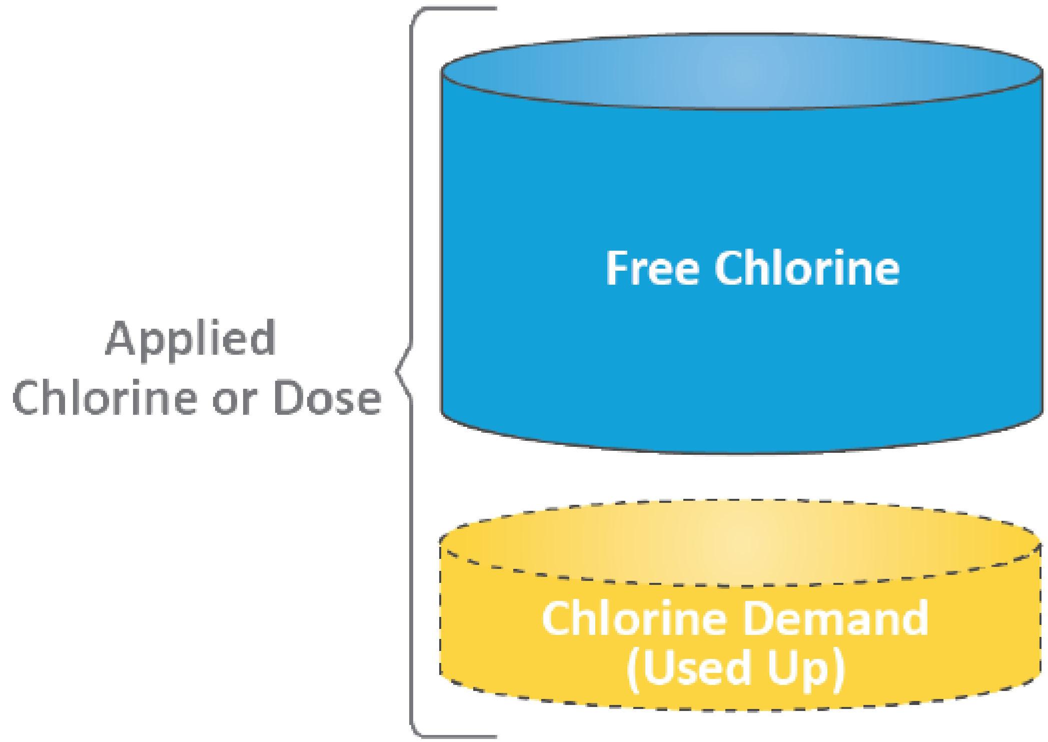
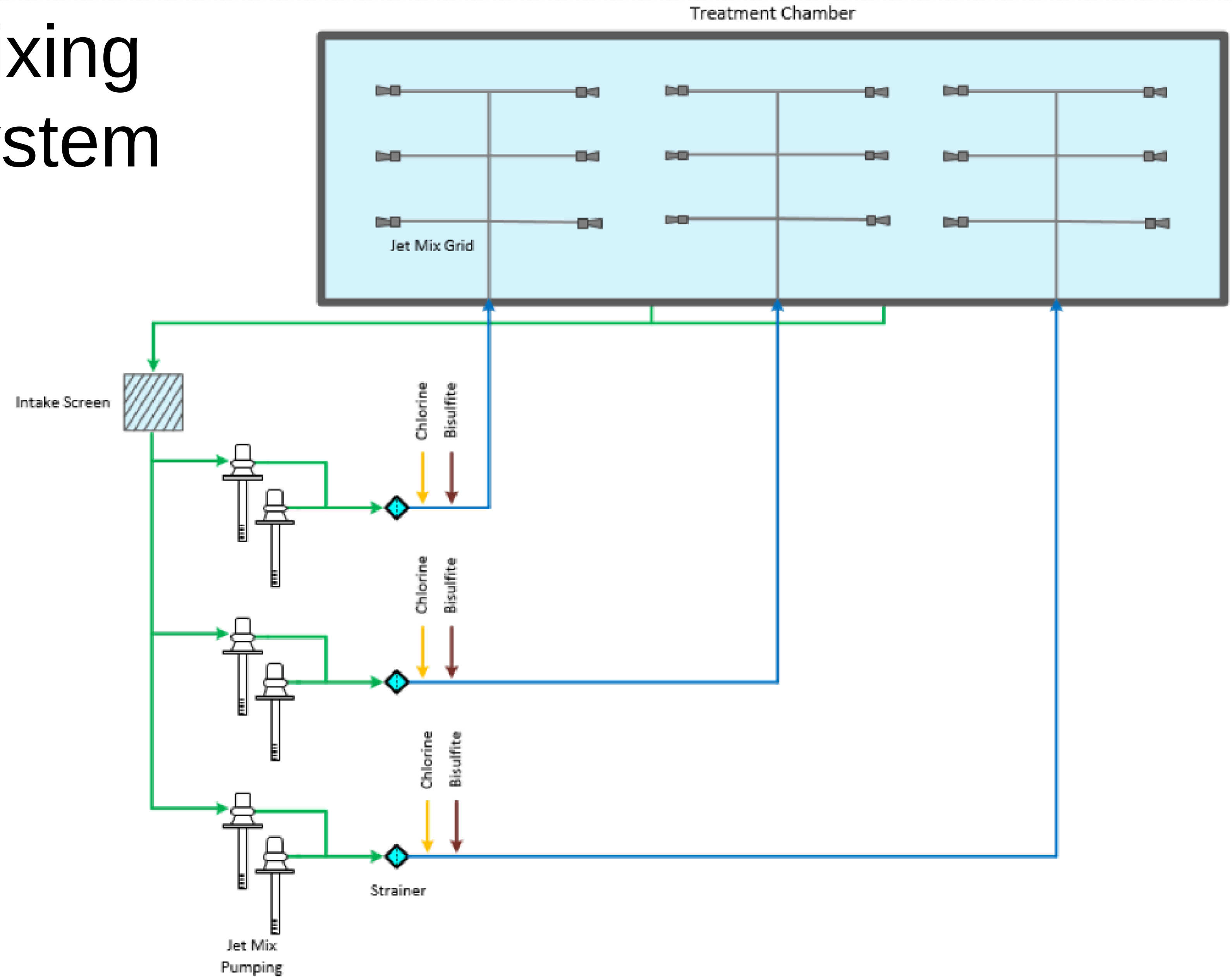


Figure 4. Chlorine Fate

Mixing system

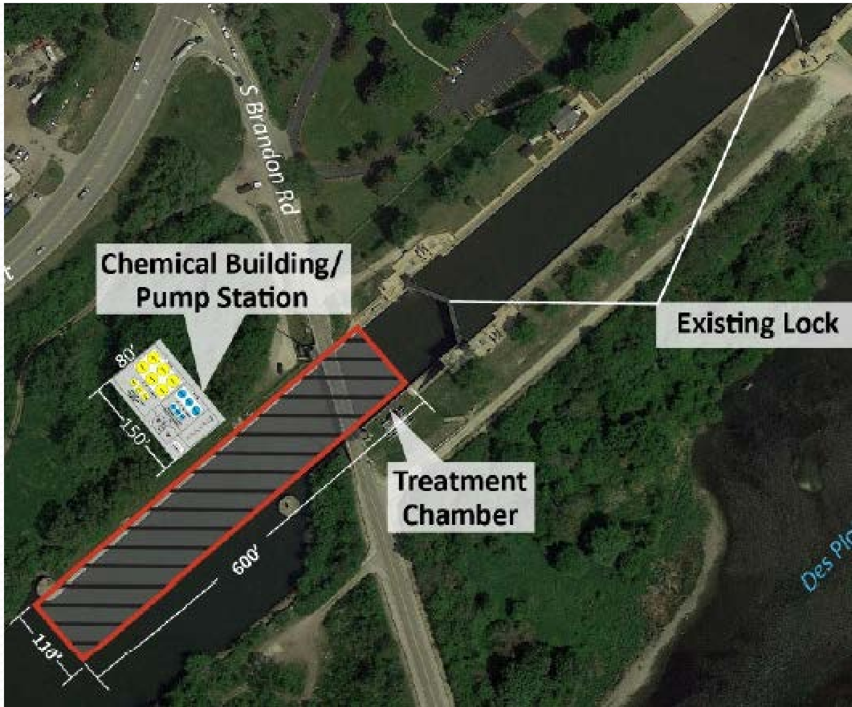


Treatment Considerations:

- use sodium hypochlorite solution as active agent
- use sodium bisulfate to detoxify
- assume chlorine demand of river water is 20 mg/l
- assume treatment concentration of chlorine is 10 mg/l
- evaluate contact times of 15 and 30 minutes
- mix chemicals in 15 minutes

Treatment Chamber:

- in approach channel (but could be lock itself)
- released lockage water routed around chamber
- fish deterrents at head of channel and u/s side of lock
- isolated from river by gates
- width and length same as lock
- add 4.5 feet to depth for mixing equipment



Amount of chemicals needed:

Table 3. Chemical Feed Summary

Parameter	Sodium Hypochlorite Solution	Sodium Bisulfite Solution
Chemical Dose (mg/L)	30 (20 chloride demand, 10 residual)	17
Concentration	12.5 percent	40 percent
Lock Volume (million gallons)	6.67	6.67
Required Chemical (Gallons per Lockage)	1,600	300

Conceptual building layout

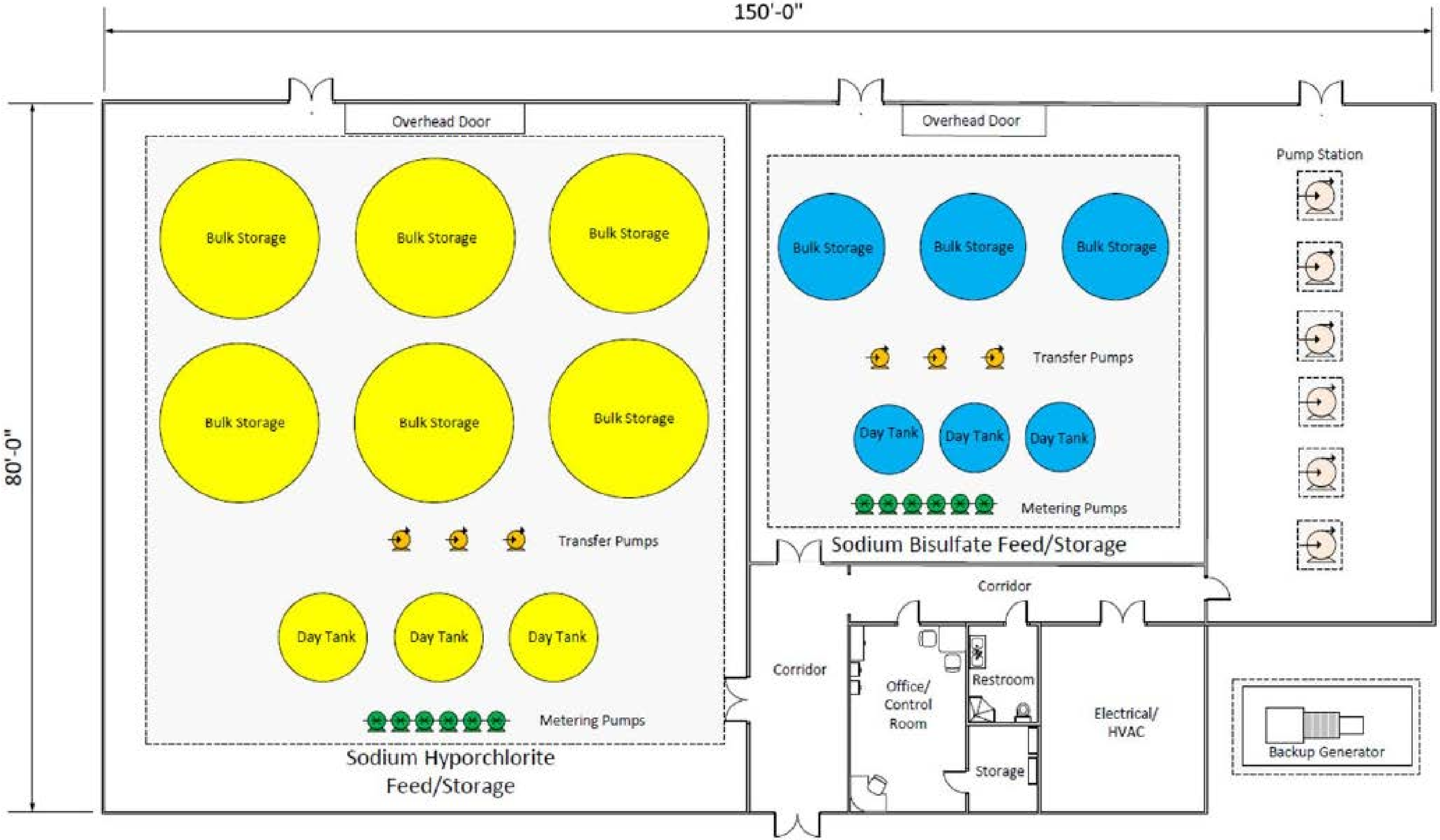


Figure 8. Conceptual Chemical Building Layout

Table 13. Opinions of Probable Cost

Component	Construction Costs	Non-construction Costs	Total
General Building Components	$3,700,000	$1,200,000	$4,900,000
Sodium Hypochlorite Solution Facility	$10,000,000	$3,300,000	$13,300,000
Sodium Bisulfite Solution Facility	$3,200,000	$1,000,000	$4,200,000
Jet Mix System and Intake Screening	$12,900,000	$4,200,000	$17,100,000
Emergency Generator	$1,400,000	$500,000	$1,900,000
Total	**$31,200,000**	**$10,200,000**	**$41,400,000**

Note: Non-construction costs include items such as permitting, engineering, legal, administrative, construction inspection, and other related costs.

Table 14. Project Cost Adjustments

Item	Additional Total Cost
Increased Chlorine Demand (10 mg/L) for a Total Chlorine Dose of 40 mg/L	$4,100,000
Speed Up Mixing Time from 15 to 5 Minutes	$2,100,000

Total treatment time

Table 7. Cycle Times

Mixing Time	**15 minutes**	**5 minutes**	**15 minutes**	**5 minutes**
Contact Time	**30 minutes**	**30 minutes**	**15 minutes**	**15 minutes**
Mixing Time (minutes)	15	5	15	5
Pump Size (HP)	125	175	125	175
Chlorine Contact Time (minutes)	30	30	15	15
Mixing and Dechlorination Time (minutes)	15	5	15	5
Total Treatment Time (minutes)	**60**	**40**	**45**	**25**

Annual operational costs:

- Treatment costs $5.2 to 8.1 million
- Other operational costs

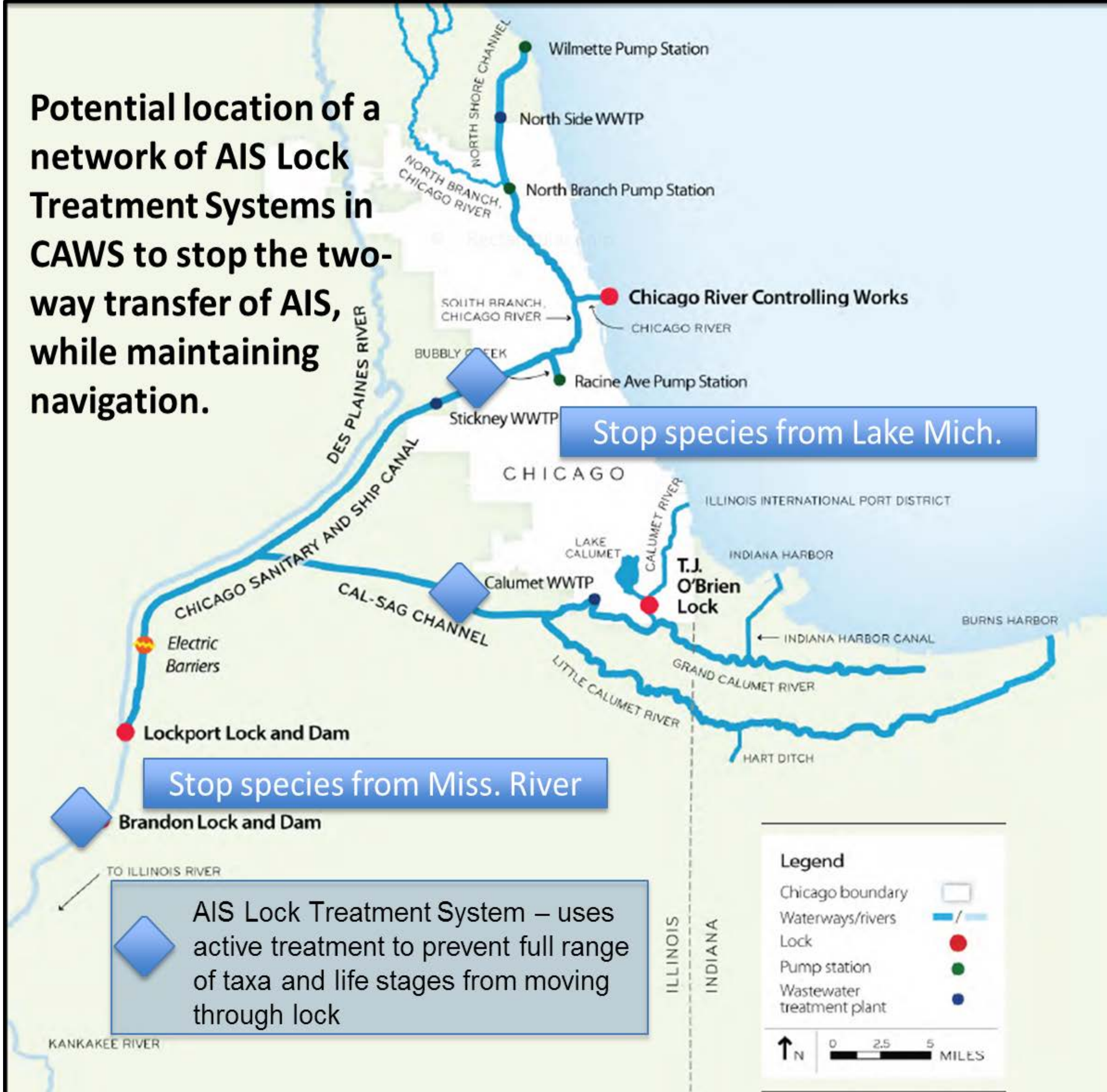
Table 16. Additional Annual Operational Costs

Item	Annual Cost
Annual Operations Staff[1]	$400,000
Annual Building Cost, Energy[2]	$40,000
Equipment Maintenance	$220,000
Misc. Additional Costs	$110,000
Total Additional Annual Operating Costs	**$770,000**

[1]Assumes four full time equivalents at $100,000 each.

[2]Does not include demand charges for high energy users.

- Total annual operational costs $6 to 9 million



Potential location of a network of AIS Lock Treatment Systems in CAWS to stop the two-way transfer of AIS, while maintaining navigation.
Wilmette Pump Station
North Side WWTP
NORTH SHORE CHANNEL
NORTH BRANCH, CHICAGO RIVER
North Branch Pump Station
SOUTH BRANCH, CHICAGO RIVER
Chicago River Controlling Works
CHICAGO RIVER
BUBBLY CREEK
Racine Ave Pump Station
Stickney WWTP
Stop species from Lake Mich.
DES PLAINES RIVER
CHICAGO
CHICAGO SANITARY AND SHIP CANAL
ILLINOIS INTERNATIONAL PORT DISTRICT
CALUMET RIVER
LAKE CALUMET
INDIANA HARBOR
T.J. O'Brien Lock
Calumet WWTP
CAL-SAG CHANNEL
BURNS HARBOR
INDIANA HARBOR CANAL
Electric Barriers
GRAND CALUMET RIVER
LITTLE CALUMET RIVER
Lockport Lock and Dam
HART DITCH
Stop species from Miss. River
Brandon Lock and Dam
TO ILLINOIS RIVER
AIS Lock Treatment System – uses active treatment to prevent full range of taxa and life stages from moving through lock
ILLINOIS
INDIANA
KANKAKEE RIVER
Legend
Chicago boundary
Waterways/rivers
Lock
Pump station
Wastewater treatment plant
N
0
2.5
5
MILES

Work necessary to move to final design

- Complete chlorine toxicity testing
- Chlorine demand testing in CAWS
- Corrosion control strategy development
- Chlorine delivery versus onsite generation evaluation
- Mixing system performance evaluation
- Consider treatment chamber isolation gate for smaller watercraft