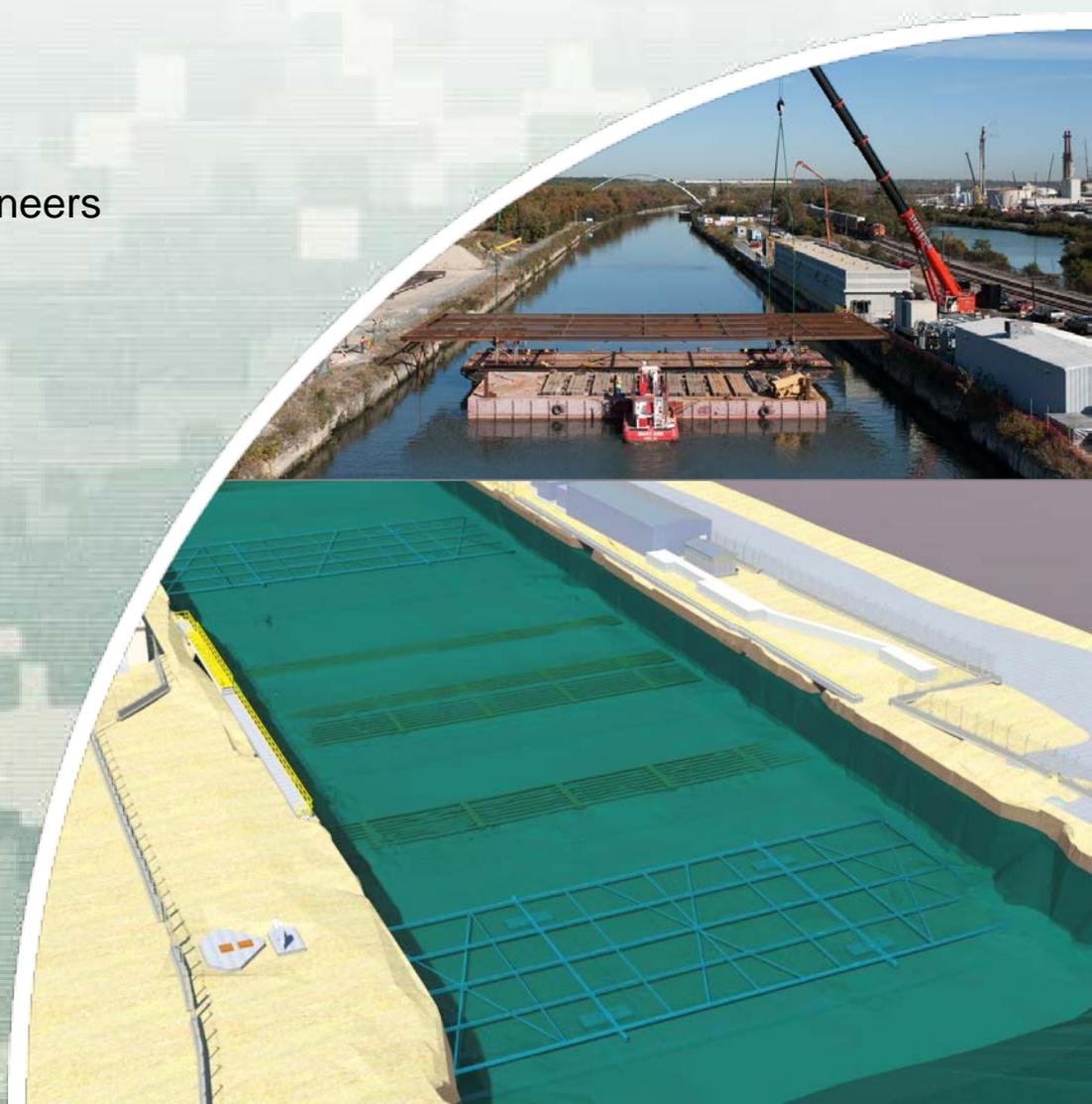


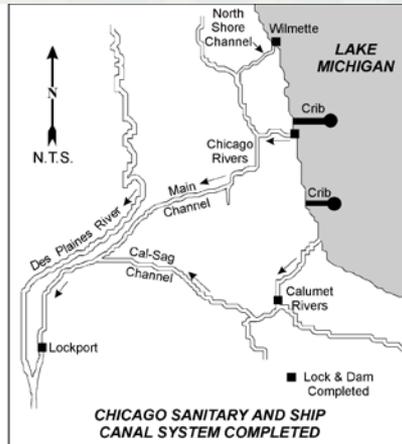
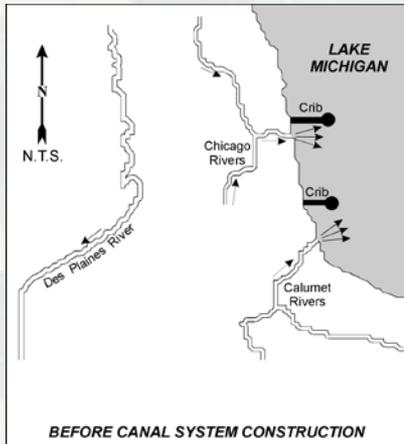
# Chicago Sanitary & Ship Canal Dispersal Barriers

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# Chicago Area Waterway System (CAWS)

- Primary pathway connecting the Great Lakes and Mississippi River basins
- Consists of 78 miles of canals and modified streams
- Five outlets to Lake Michigan within the CAWS



- The Chicago Sanitary and Ship Canal remains an important pathway for navigation and the transport of wastewater effluent and storm water runoff.



# Invasive Species

- Not native
- Presence has potential to cause harm to environment, economy, or human health
- Preventing introduction is critical

## Potential Interbasin Movement of Invasive Fish

### Mississippi River Basin

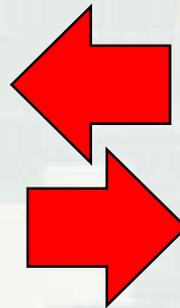
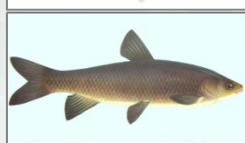
Bighead Carp



Silver Carp



Black Carp



### Great Lakes Basin



Tubenose Goby



Ruffe

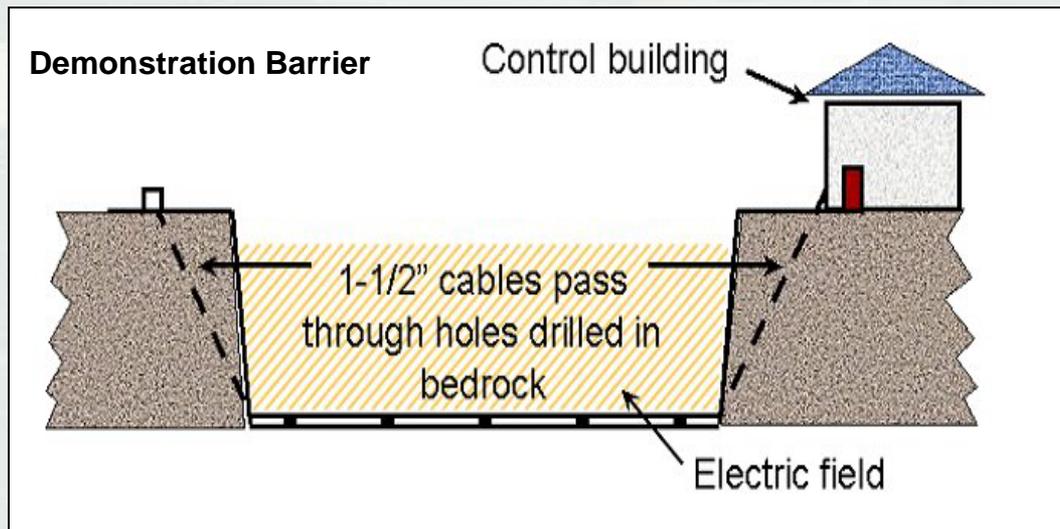


Sea Lamprey



# How Do The Dispersal Barriers Work?

- Electrodes are secured to the bottom of the canal
- Electrical cables connect the electrodes to the control building
- Pulsing DC current is generated in the control building and sent to the electrodes creating an electric field in the water
- The electric field increases in strength from the upstream & downstream edges to the center
- A fish entering the field becomes increasingly uncomfortable & is discouraged from swimming across it



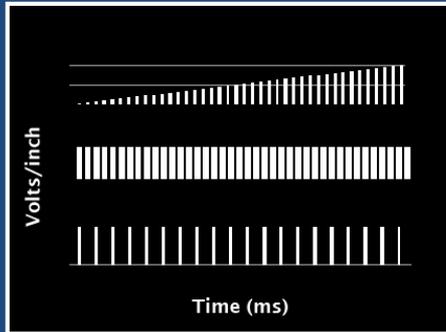
# Factors Influencing Barrier Effectiveness

## Effectiveness of the Barriers is Influenced by Technical Factors

Field strength

Pulse-length

Frequency



## Effectiveness of the Barriers is Influenced by Biological Factors

Species

Fish size



Bighead carp

Silver carp



Noel M. Burkhead

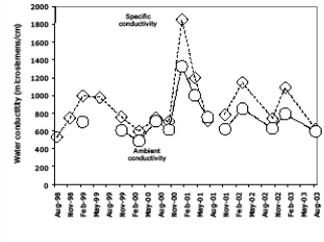


<http://www.asiancarp.org>  
 Images of fingerling above from Yi, S., Z. Liang, Z. Yu, S. Liu, and M. He. 2005. A study of the early development of grass carp, black carp, silver carp and bighead carp of the Yangtze River. Pages 15-51 in D.C. Chapman, editor. Early development of four cyprinids native to the Yangtze River. US Geological Survey Data Series 239.

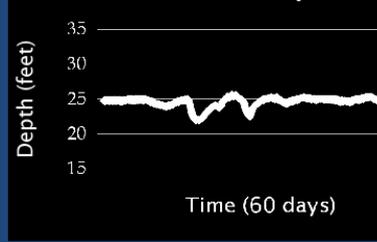
<http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=551>

## Effectiveness of the Barriers is Influenced by Environmental Factors

### Water conductivity

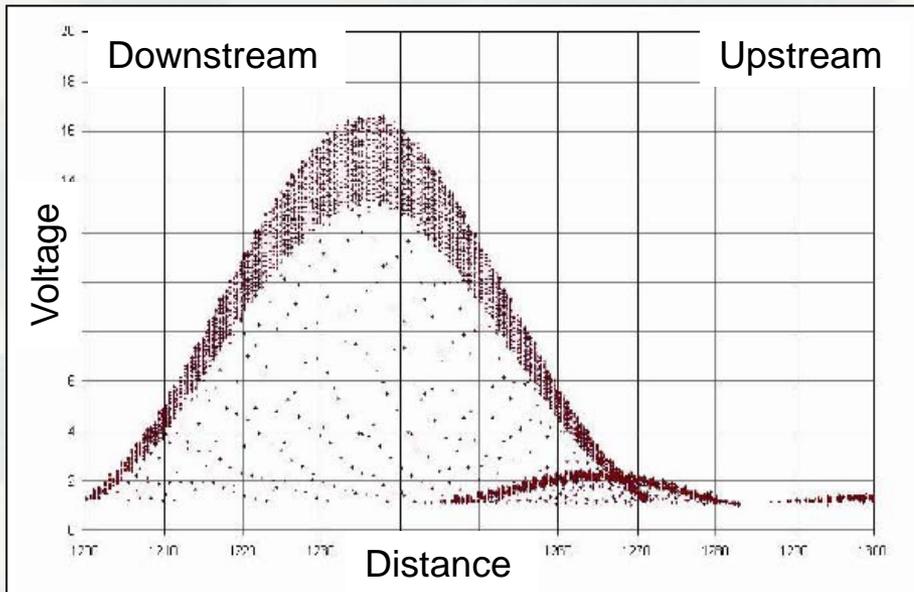


### Water depth



# Demonstration Barrier

- Upstream benthic-focused electric field
- Downstream full water column electric field



Electric Field Near Water Surface

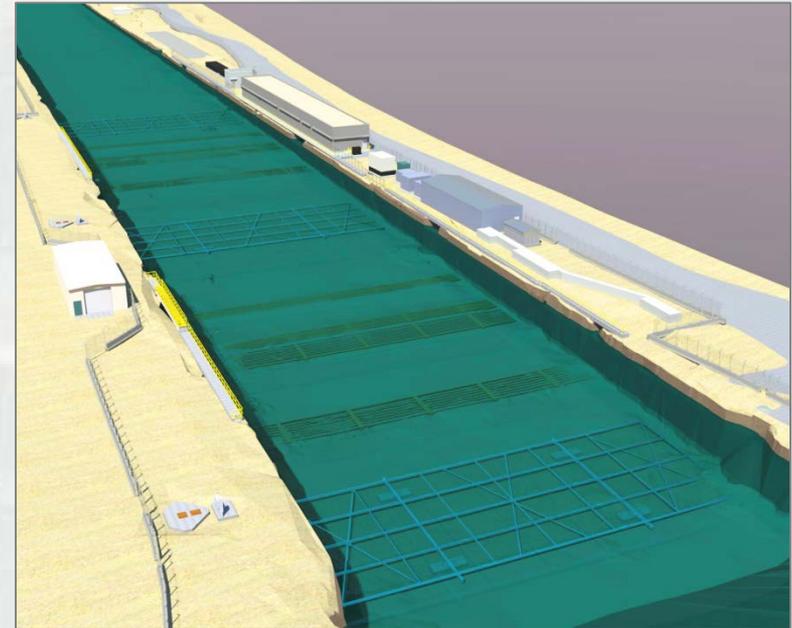
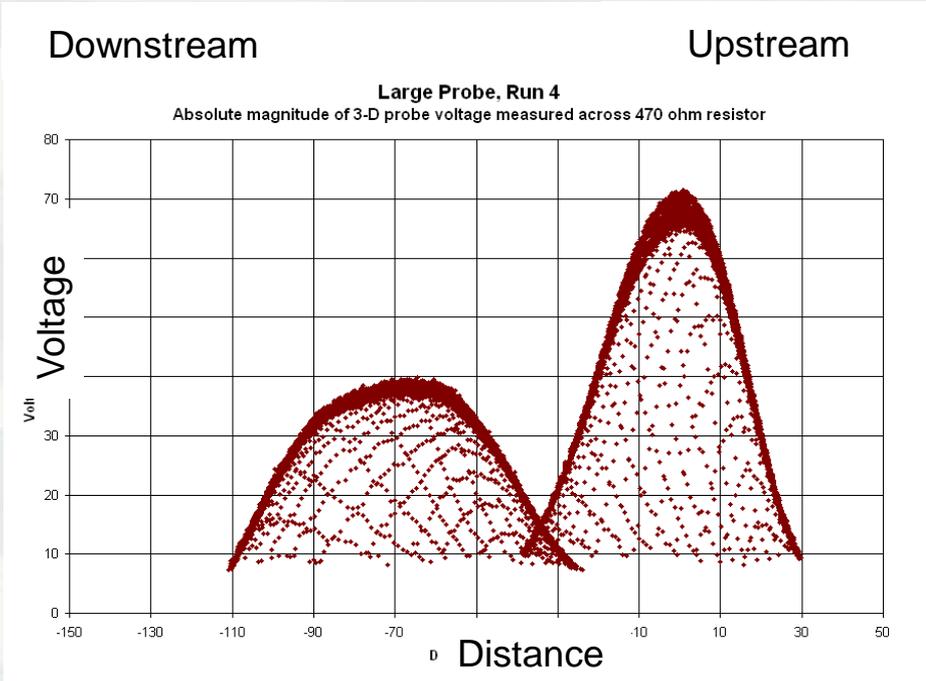


Barrier	Date of Activation	Voltage (volts/inch)	Frequency (Hz)	Pulse Duration (ms)
Demo	2002	1.0	5	4



# Barriers IIA & IIB

- 1 wider, lower-strength electric field
- 1 narrower, higher-strength electric field

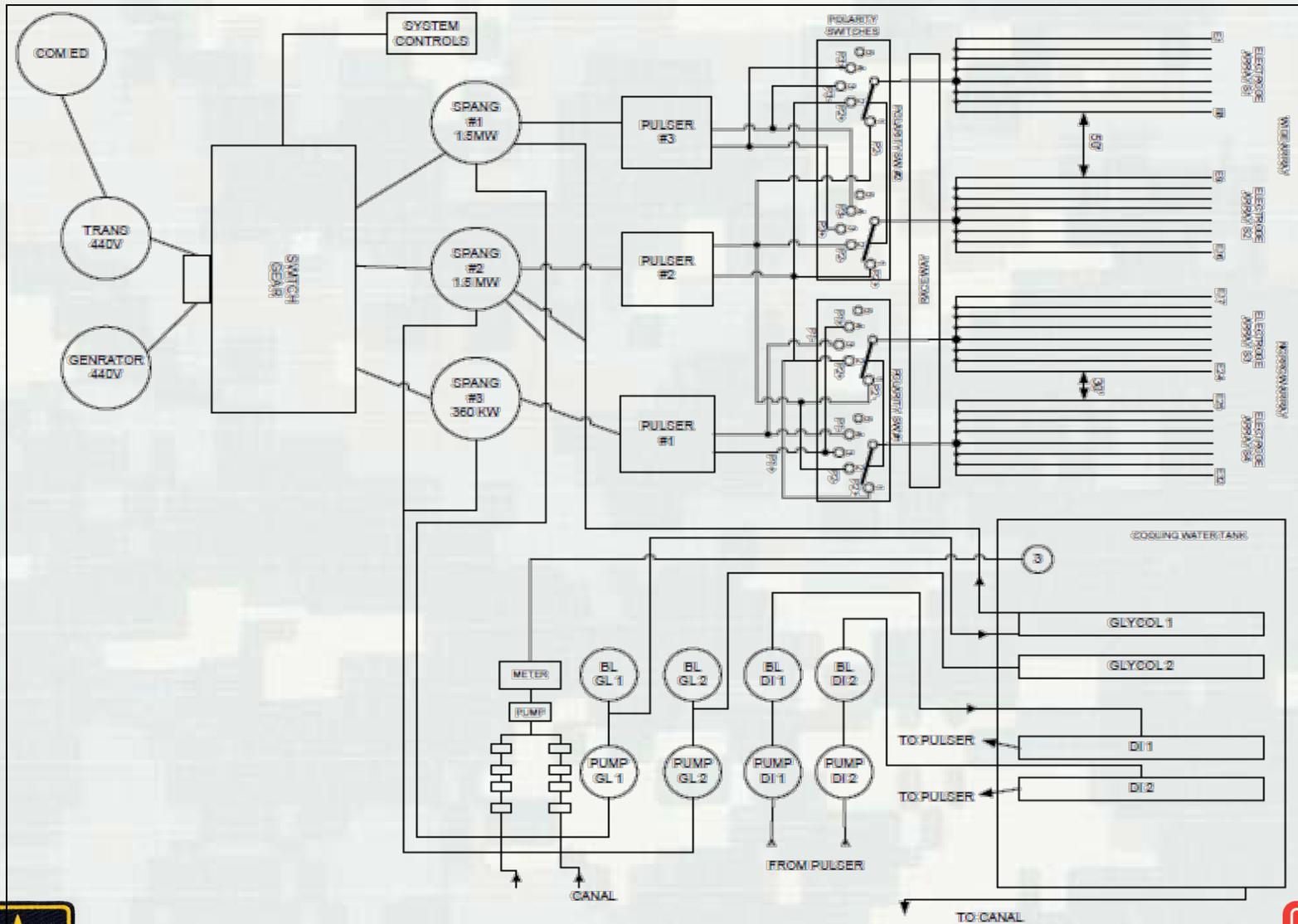


Electric Field Near Water Surface

Barrier	Date of Activation	Voltage (volts/inch)	Frequency (Hz)	Pulse Duration (ms)
IIA	2009	2.3	34	2.3
IIB	2011	2.3	34	2.3



# Electrical & Mechanical Systems Overview



# Permanent Barrier I - Design Features

- Two high field arrays
- Demo Barrier used as low field array
- Increased power capacity - ~3X Greater than A or B
- Redundant power feeds
- Administrative area
- Storage areas



# Permanent Barrier I - Status

- Completed
  - ▶ Site preparation
  - ▶ Installation of underwater electrodes & parasitics
  - ▶ Purchase of specialized long-lead electrical equipment
- Building Contract
  - ▶ Began construction Mar 2015
  - ▶ Currently working on vertical construction
- Backup Power Contract
  - ▶ Awarded Aug 2015
  - ▶ Preparing for spring mobilization

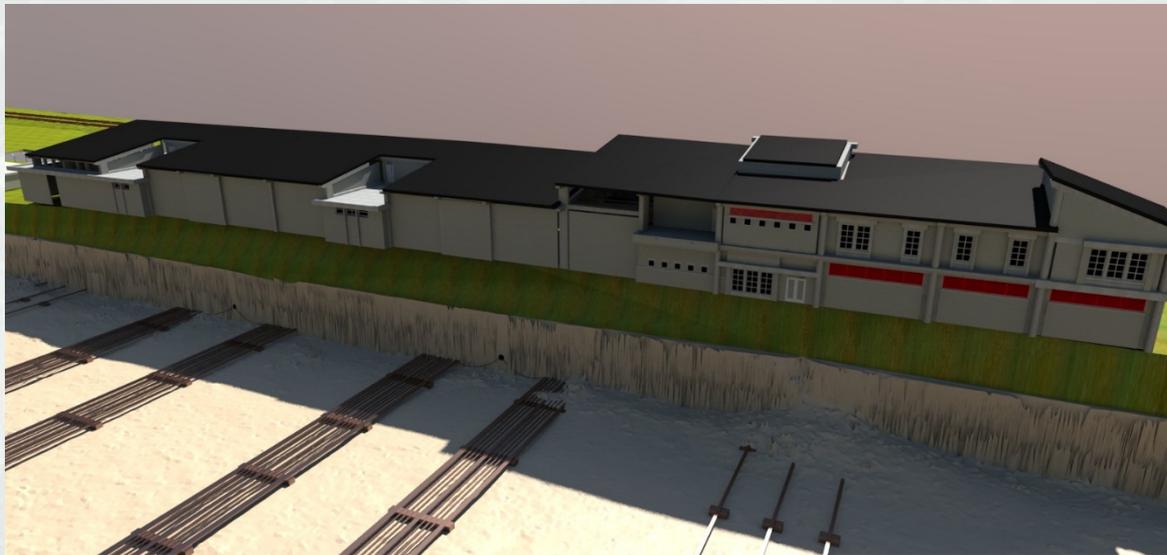


Building Construction as  
of 21 Dec 2015



# Permanent Barrier I - Schedule

- FY16
  - ▶ Continue building construction
  - ▶ Begin install of backup power systems
  - ▶ Award electrical equipment install contract
  
- FY17
  - Q1 - Complete building construction & backup power install
  - Q2 – Complete electrical equipment install
  - Q3 – Complete startup/safety testing



Rendering of  
Completed  
Permanent Barrier I



# Electrical Equipment Install Contract

- Acquisition Strategy Being Evaluated
- Potential Scope of Work
  - ▶ Installation of pulse-generating electrical equipment
  - ▶ Programming & installation of pulse-generating equipment control system
  - ▶ Startup testing & commissioning
- Equipment in Storage
  - ▶ Rectifier units
  - ▶ Polarity switches
  - ▶ Electrical control cabinets



Electrical Equipment in Storage



# Safety Concerns

- In the Water
  - ▶ Risk of injury or death to person in water
  - ▶ Potential sparking between metal objects (like barges!)
- Stray Voltage in Ground
  - ▶ Electric shocks to humans
  - ▶ Corrosion of structures, utilities, etc.
  - ▶ Interference with railroad signaling
- EMF



# Afternoon Agenda

- Electrical Systems Overview
- Cooling Systems Overview
- Control Systems Overview
- In-Water Voltage Measurements
- Fish Monitoring
- Potential Upcoming Opportunities

