

# RECLAMATION

*Managing Water in the West*

## **Lower Colorado Dam's Quagga Mussel Assessment and Potential Control/Preventive Program**



U.S. Department of the Interior  
Bureau of Reclamation

# Agenda

- **BACKGROUND**
- **BUREAU OF RECLAMATION LOWER COLORADO DAMS (LCD) CONTRACTED WITH QUAGGA MUSSEL CONSULTANT – RENATA CLAUDI (RNT CONSULTING)**
- **LESSONS-LEARNED FROM ONTARIO POWER PLANTS**
- **COMPREHENSIVE FACILITY REVIEW OF THE DAMS**
- **FINDINGS & POTENTIAL CONTROL/PREVENTIVE MEASURES**

# Site Visit Experience Ontario Hydro Power Facilities (reactive approach)



Sir Adam Beck #2



Sir Adam Beck #1



DeCew #2



Pump Generating Station

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# Nanticoke Coal Fired Facility Ontario (proactive approach)



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# Over time if left untreated

- Transformer cooling water piping plugged at Ontario Hydro Power



Water Cooled  
Transformer Piping

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# Ontario Hydro Plant Unit Coolers



Dead Mussels Found in Unit Coolers

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# Quagga Mussel Infestation at Dams; What have we learned and what do we recommend

**RNT Consulting Inc.**

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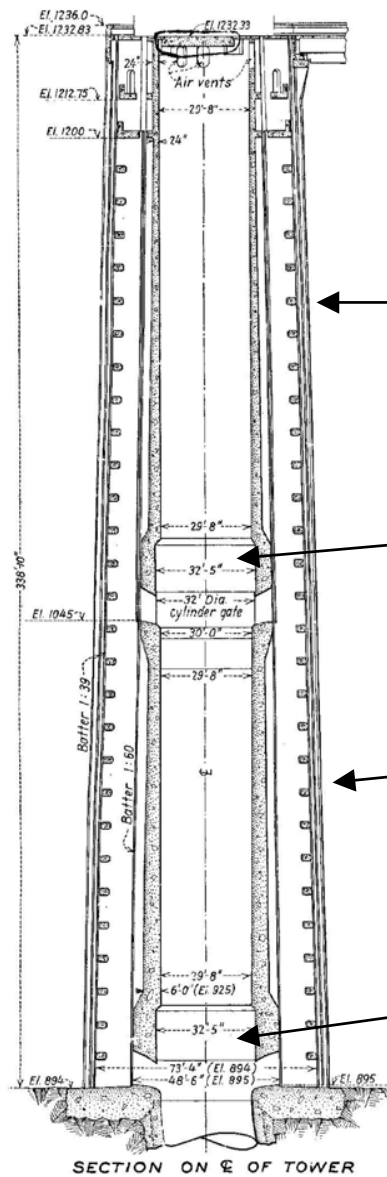
# Observations from inspection of external surfaces

- Mussels are present in the lower penstock (Living 220' below Lake evaluation)



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Elev 1111  
Dec 2007 Lake  
Mead Level

Elev 1045  
66'

Elev 970  
141'

Elev 894  
217'



Elevation 1045, (66' below water)



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# Sampling Plates at Parker Dam

## November 11/07 – 6 Weeks of Settlement



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# Stainless Steel Pipe 11/07



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# Davis Dam Penstock Gate Oct.07



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# Proactive vs. Reactive Control Measures

- Proactive

Does not allow growth of mussels in the system or on the surface protected

- Reactive

Does allow mussels to grow in the system or on the surface. Established populations have to be eliminated periodically

# Findings & Potential Control Measures

- All three dams use the same settlement substrate on the sampling plates
- Same dimensions
- At the same depth (10ft, 20....down to maximum depth)
- Examine the plates at the same time interval and in the same manner
- Multiple strings of sampling plates lakeside and in the tailbay



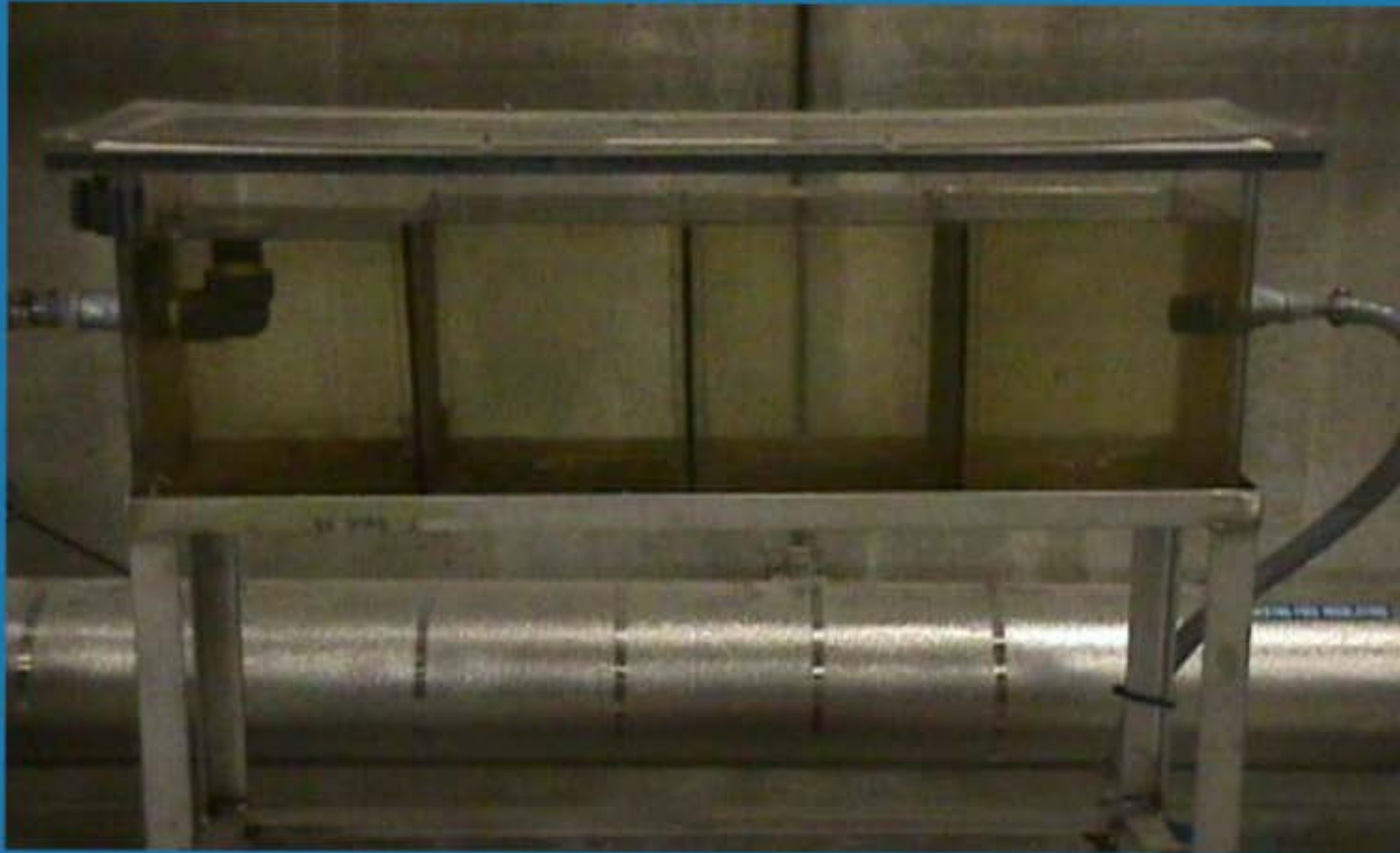


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# Install Side stream sampler for plant monitoring

## **Bio-box**



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# Bio-Box Spiked with Live Mussels

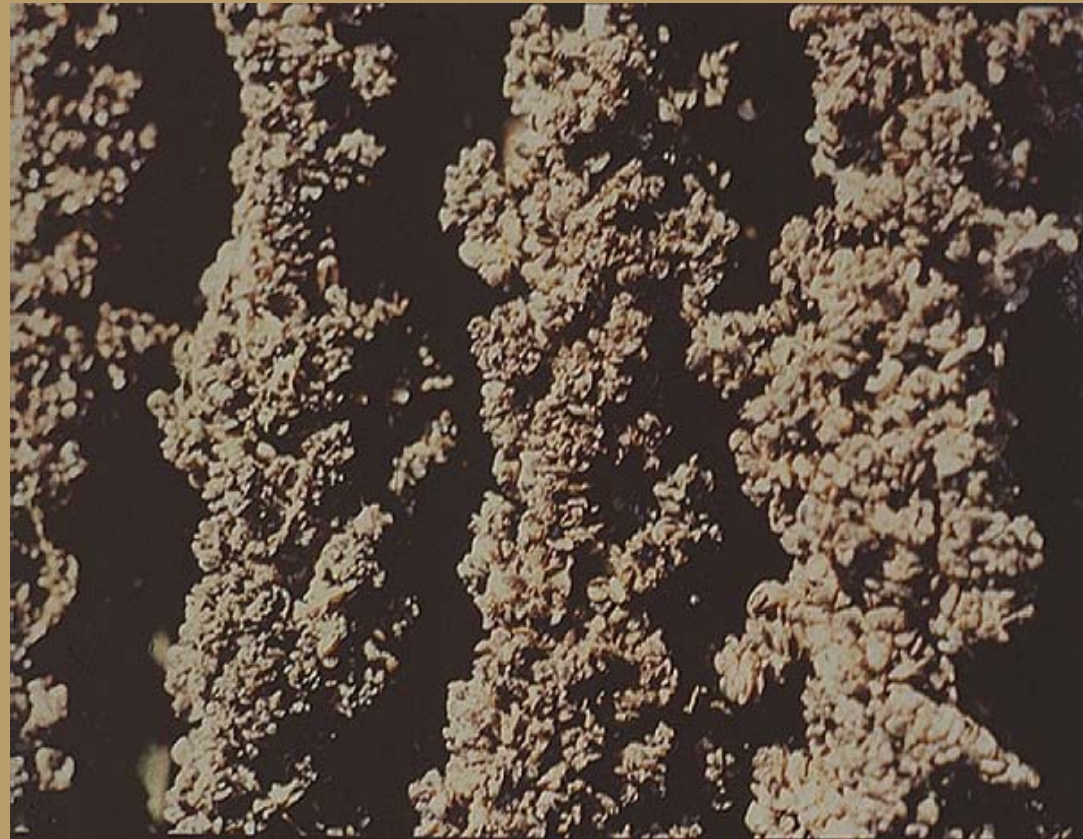


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# Options for External Structures\*

**\*Structures That Are in Direct Contact With the External Environment; No Isolation Is Possible**



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# Reactive Options for External Structures

## Mechanical Cleaning



- de-water and use powerwash
- underwater, scrape and vacuum or powerwash

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# Proactive Options for External Structures

- Antifouling Coatings - for both steel and concrete
- Toxic, copper based coatings
- Non-toxic, silicone based is (Foul Release Coating)
- Life-span 5-7 years before topcoat needs to be refreshed



# Substrate Preference

(Decreasing from Top to Bottom)

- Copper
- Galvanized Iron
- Aluminum
- Acrylic
- PVC
- Teflon
- Vinyl
- Pressure Treated Wood
- Black Steel
- Polypropylene
- Asbestos
- Stainless Steel



**Kerr Lock and Dam (COE),  
Tulsa OK**

**Source - Kilgour and Mackie, 1993**

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# Initial Suggestions for Control

- Rapid Response Option (if settlement and shell transport increases dramatically and suddenly):
  - Install portable chlorine skids to protect critical areas



- Use thermal treatment where possible
  - 32°C for 48 hours (90° F)
  - 40°C for 1 hour (104° F)

Use weak acids to dissolve shells and corrosion products

Mechanical cleaning as system performance deteriorates

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# Oxidizing Chemical Treatment

- Chlorine
- Bromine
- Chlorine dioxide
- Chloramines
- Ozone
- Potassium permanganate



# Emerging Options

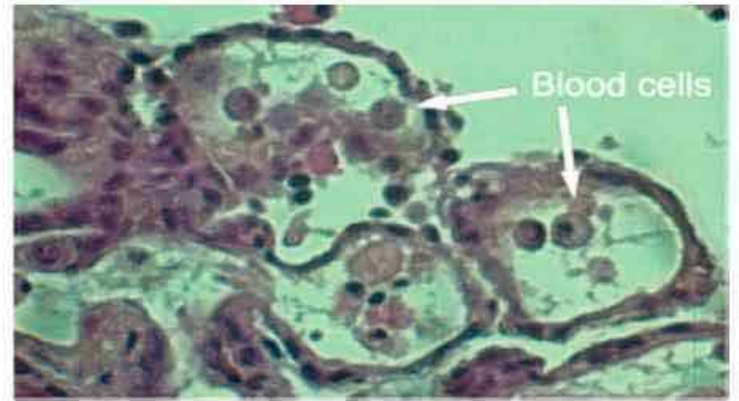
- Bacterial product (Marrone Organic Innovations), zebra mussel specific chemical....being tested on Quagga now

## How does it work?

The bacteria produce natural compounds that kill the mussels when ingested. It destroys the mussels' digestive system.



In healthy mussels, epithelial cells (arrows) appear as a thick layer lining the tubules of the digestive gland.



Following bacterial treatment, epithelial cells are destroyed. Blood cells are abundant as the digestive gland hemorrhages.

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# Proactive Options for Internal Piping Systems

- Sand/media filtration - has to remove all particles greater than 40 micron
- Mechanical filtration - has to remove all particles greater than 40 micron

# Example of Self Cleaning Filter

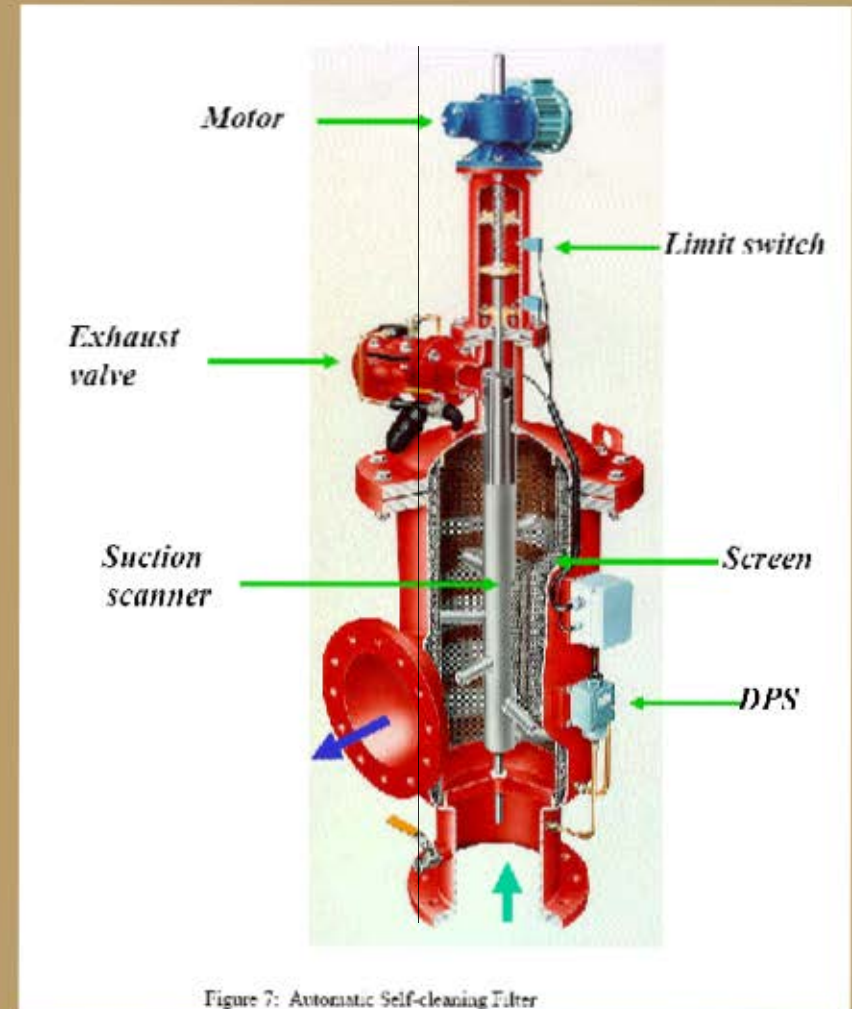
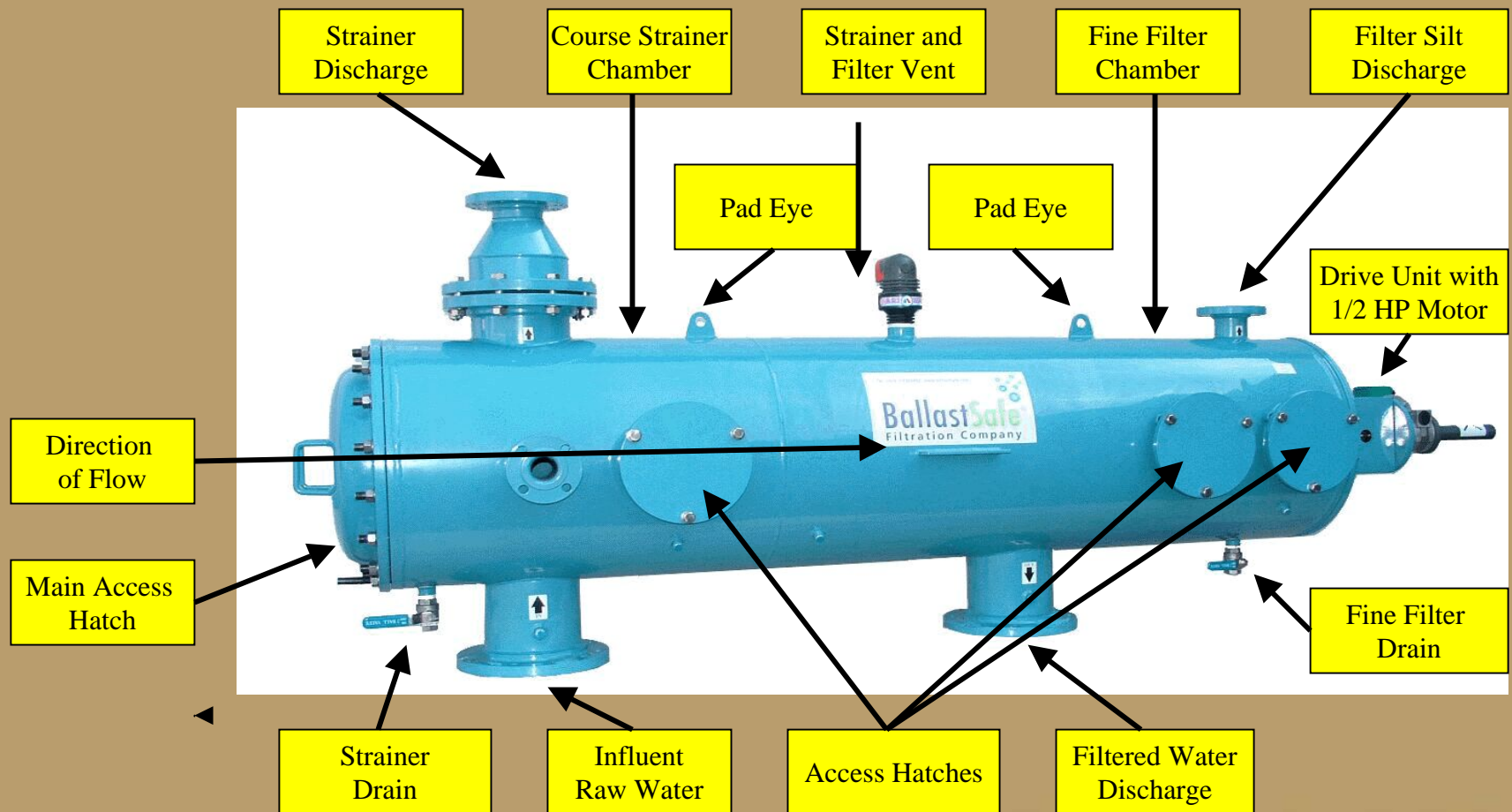


Figure 7: Automatic Self-cleaning Filter

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# 25 to 50 MICRON SELF CLEANING FILTER



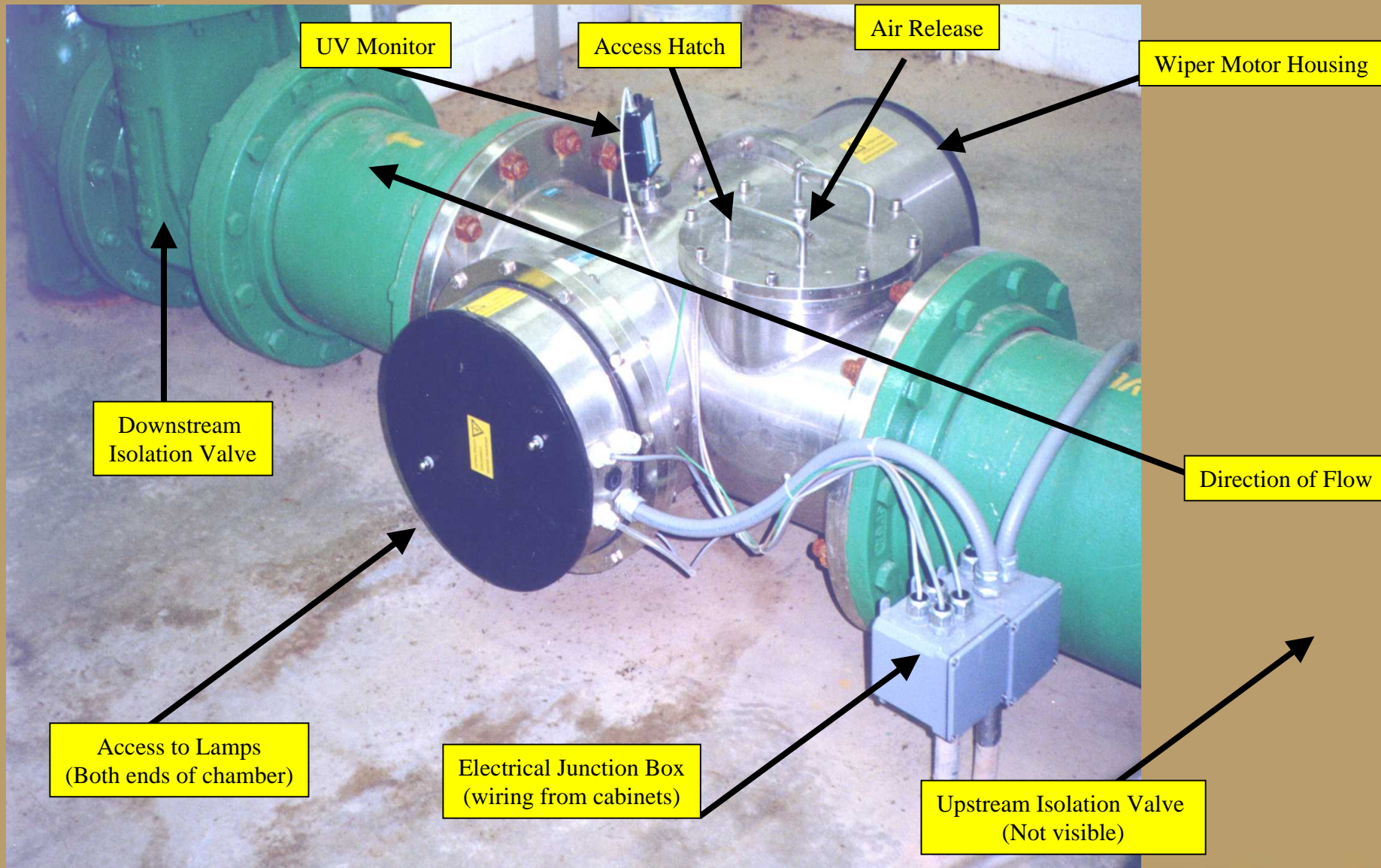
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# Additional Proactive Options for Internal Piping Systems

- UV systems
- Closed Loop Cooling
- Oxidizing chemicals
- Non-Oxidizing chemicals

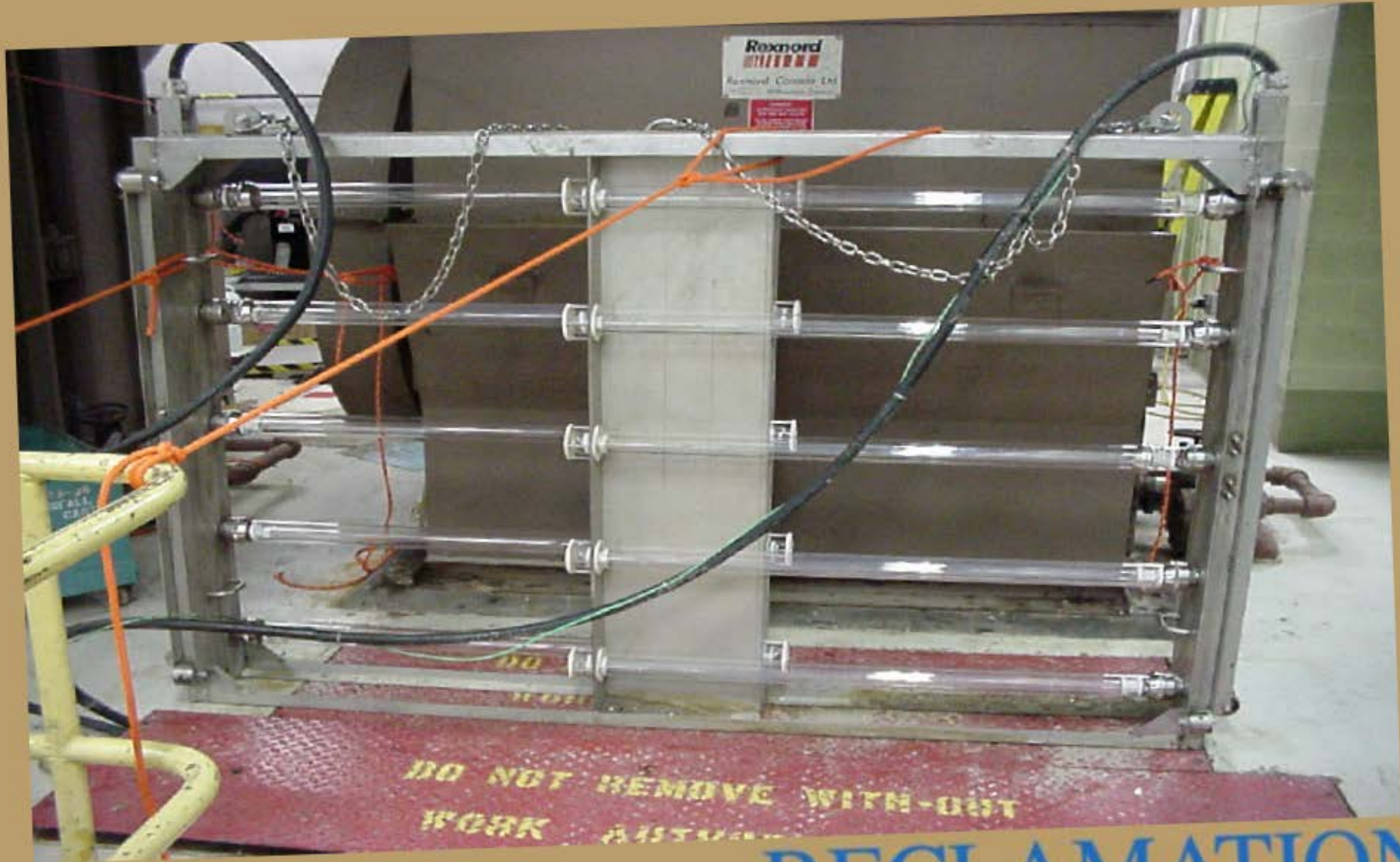


# In Line Pipeline UV Installation



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# UV Light Bank for Open Channel



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# What Water Storage and Delivery Facilities are Vulnerable to a *Dreissena* Mussel Infestation?

Comparison of Zebra Mussel Colonization Potential with Environmental Tolerances				
Variable	Colonization Potential (Infestation Probability)			
	High	Moderate	Low	Very Low
Salinity, ppm	0-1,000	1,000-4,000	4,000-10,000	10,000-35,000
Calcium, ppm	25,000-125,000	20,000-25,000	12,000-20,000	<12,000
pH	7.4-8.5	7.0-7.4 8.5-9.0	6.5-7.0	<6.5 >9.0
Water temperature °C (°F)	17-25 (63-77)	25-27 (77-81)	15-17 (59-63)	<12 (<50)
Turbidity, cm (Secchi disk)	40-200	20-30	10-20 200-250	<10 >250
Dissolved Oxygen, ppm	8-10	6-8	4-6	<4
Water velocity, (ft./sec.)	1.6-2.3	2.3-3.3	3.3-6.6	>6.6

# Cost for Mussel Control

- Ontario Hydro Experience

Average cost per MW = \$1020/MW (Capital Costs)

Average Annual Operating Cost = \$50/MW



# Consultant and LCD Quagga Mussel Point of Contact

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## QUESTIONS



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