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Zebra Mussel Research Technical Notes

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Components of Navigation Locks and Dams Sensitive to Zebra Mussel Infestations

Background

A working group of experts knowledgeable on navigation locks and dams met in January 1992 to identify facility components most at risk of failure or disruption of service due to zebra mussel infestation. An outline of possible control measures was also developed for each component as an initial step toward developing control strategies.

Additional information

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Components of concern

The Canadian and St. Lawrence Seaway lock operating agencies have limited experience, up to 3 years at certain locks, with infestations. These locks are normally dewatered and cleaned during the winter nonoperating season. Initial settling and detection of zebra mussels have been observed as far south as Melvin Price Lock near St. Louis and within the Tennessee Valley. The general expectation is that the 1992 and 1993 growth season will be significant for many U.S. locks that are located in areas suitable to zebra mussels.

Small flow passages that are exposed to raw water with immature zebra mussels can be fouled quickly and completely. Hydrologic measurement devices, such as transducer ports and gage wells, are an immediate concern. Similarly, raw water cooling systems, project irrigation and fire prevention lines, and the associated screens are immediate concerns. The application of biocides (chlorine-based types are common), anti-foulant coatings, and back-flushing are being investigated at particular projects. Large gates and valves, such as lock chamber gates and culvert filling and emptying valves, are massive and commonly involve large forces for operation. These devices are not considered at risk during the 1992 operating season; however, project personnel are advised to be aware of a potential long-term infestation and to observe the behavior of the zebra mussels on these components.

Navigation lock and dam components addressed during the working group meeting are described in the following section.

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Measurement systems

Transducers

Potential problem: Occlusion of the pipe leading from the chamber to the transducer is of concern. Erroneous readings lead to incorrect conclusions regarding project conditions. No readings lead to nonoperable automated systems and lack of data for project control.

Potential solutions:

- Early detection. The transducers sense pressure in a polyvinyl chloride (PVC) pipe that terminates in the lock chamber. Early detection may be obtained by inserting a similar PVC pipe to the same elevation in a nearby ladder recess; the second pipe would be inspected regularly by the lock operators. The early detection should be more timely than detection by observing errors between staff gage and transducer values.
- Field remedies. Protective coatings are not workable because of the pipe material (PVC). Similarly, screens are considered not workable because of the need for an extremely fine mesh and the probable of occlusion of the screen. The suggested solution is to regularly flush the system with an appropriate biocide (chlorine).

Gage wells

Potential problems: The occlusion of the pipe that leads from well to river and the weight of mussels on the float can lead to erroneous readings. Erroneous readings can lead to incorrect conclusions regarding project conditions particularly when the readings are automated and transmitted to a centralized location.

Potential solutions:

- Early detection. The wells are usually approximately 2 feet in diameter with a 4- to 6-inch-diameter PVC pipe leading to the river. Consequently, the conditions around the float and pipe are nearly impossible to inspect visually. Maintenance is often on an annual basis. An artificial substrate within the well is a potential means of early detection.
- Coatings. A protective coating of material not amenable to mussel attachment is a possibility. However, discussion comments indicated that even these coatings may be acceptable to zebra mussels when no other settling surfaces are present. The suggested solution is to regularly add an appropriate biocide (chlorine) to the well. A further suggestion was to install a dummy well or use a second well for comparison. The second well would be equipped with an artificial substrate and regularly inspected. Data from the two wells is to show the efficacy of the addition of biocide.

Piezometers

Potential problems: Most piezometer lines are for geotechnical measurements and lead into a soil-pressure area. Consequently, these devices are not threatened by zebra mussels. Openings that are exposed to raw water, such as the transducer line above, could become occluded and are discussed separately.

Raw-water systems

Screens

Potential problem: The small screens that are used at raw water intakes were discussed in conjunction with transducers and gage wells. Screens that are welded to the wall cannot easily be removed for either replacement or cleaning.

Potential solutions:

- The Louisville District is designing new and replacement screens to be removable; that is, not welded in place.
- The choice of screen materials and mesh sizes was mentioned but not discussed in detail.

Cooling systems

Potential problems: Cooling systems are used often enough so that a significant zebra mussel presence can be expected. The mussels can occlude the intake screens and the piping, preventing normal operation leading to equipment damage.

Potential solutions:

- Certain systems may be modified to use chlorinated (municipal) water.
- Regular backflushing using nonheated water could be adequate.
- Backflushing with heated water (above about 100 degrees Fahrenheit) was discussed in some detail. The advantage of heated water is that it is fatal to the mussels. A test of a new design, in which temperature measurements are made relative to the efficiency of zebra mussel mortality, was suggested.

Fire-prevention sprinkler systems utilities

Potential problems: Many of these systems are either dry most of the time or use water that is commercially supplied or from wells. For systems exposed to zebra mussels, the comments for cooling systems are generally applicable. Caution regarding drawing adult mussels and shells from the intake area into smaller distribution lines is a concern.

Potential solutions:

- Use noncontaminated water sources.
- Drain lines when not in use.
- Minimize leakage so that most lines are anoxic most of the time.
- Prevent shells in the intake area from being drawn into the smaller lines by means of screens, bypass lines, or backflushing.

Large gates and valves

These devices include chamber gates (miter gates and vertical lift gates), emergency gates (submerged vertical lift gates, stoplogs, and bulkheads), control gates (tainter gates and vertical lift gates), and culvert valves (reverse tainter valves). The gate of most concern is the chamber gate, then the control gate, and, of least concern, the culvert valve.

Miter gates

Potential problems: These gates have many locations that appear suitable for accumulation of zebra mussels. Potential problems include corrosion, paint deterioration, and unbalanced or excessive loadings. The seals at the sill and vertically along the gate, if torn or otherwise unable to function properly, can also

cause operational problems. The manner in which the mussels affect cathodic protection systems is unknown and a potential concern for all large gates. Normal usage should keep recesses clear for proper recessing for locks that are operated several times weekly.

Potential solutions:

- Early detection using the artificial substrate procedure is suggested. Infested locks should be operated probably at least daily to ensure that the recesses are kept clear of large accumulations of mussels.
- The gates should be cleaned and painted as part of regular dewaterings. Anti-fouling coatings should be considered.
- Lock operators should be made aware of the concern with loadings. Whenever conditions, such as deflections of the gate leaf, indicate an unusual loading condition then visual inspection using divers may be warranted.

Vertical lift gates — chamber and emergency

Potential problems: Larger increased loadings, due to sediment being combined with mussel accumulations, can occur. There is not a great deal of overload capability designed into the operating machinery for these gates. Other potential problems, associated with miter gates above, also apply to submersible lift gates.

Potential solutions:

- These gates can be raised, inspected, and cleaned if required.
- Holding the gates in the open position (air drying) will speed clearing the gates of mussels.
- The gates can be painted with an anti-fouling paint which could reduce future infestations.
- The gates should be operated at regular intervals during low usage periods to assist cleaning and clearing operations.

Control gates — tainter & vertical lift

Potential problems: Added weight for operating machinery, improper sealing, seal deterioration, corrosion, and paint deterioration are all potential problems for these gates.

Potential solutions:

- For these gates, an upstream bulkhead must be installed before inspecting and cleaning. Therefore early detection and careful observations of performance are needed. Once the bulkhead units are placed, then the gate can be fully exposed to the atmosphere, cleaned inside and out, and a protective coating applied as required. High pressure water and scraping will probably be needed. Seals and sealing surfaces can also be inspected and repaired if necessary.
- In periods of low flow, the gates can be operated regularly to clean the side and bottom sealing surfaces.

Culvert valves

Potential problems: Extra weight and friction can produce added loads for the operating machinery and paint deterioration can occur. Sealing should not be a problem with most locks due to normal usage. Because of high velocities and regular usage, these valves are considered unlikely to experience problems beyond normal repair and maintenance procedures.

Potential solutions:

- Normal usage, or periodic operation for low usage locks, should keep the sealing tracks clear.
- Valves can be cleaned on scheduled dewatering for rehabilitation of the valve.

Concrete surfaces
Infestations of zebra mussels on concrete surfaces have been observed to thicknesses up to about 10 centimeters. Some level of concern regarding the deterioration of concrete due to high ammonia levels exists. However, cleaning and disposing of large quantities of odorous debris could be a problem.

Lock culverts
Potential problems: The high velocities in the filling and emptying system probably preclude major infestation on the culvert boundaries.

Potential solutions:

- For very low usage locks, a periodic filling and emptying operation will preclude significant attachments within intake manifold, culvert, chamber manifold, and outlet manifold.
- An increase in lock operation time indicates increased hydraulic roughness in the filling or emptying system. Hence, observing operation time is a potential detection method applicable to severe infestations at low-usage locks.

Chamber walls
Potential problems: Structural damage, at least in the short term, is expected to be limited to abrasion during cleaning operations. Long term effects, due to chemical actions for example, have yet to be identified. Problems with disposal and possible odor are separately listed below.

Potential solutions:

- Early detection from observations along the wall, just below the waterline, with the water surface at lower pool should suffice.
- Cleaning is expected to be a mechanical operation. Various procedures were suggested and include scraping, high-pressure hosing (possibly barge mounted for near-surface cleaning), and scrubbers (barge mounted and used for deeper cleaning). Dewatering is probably needed for complete zebra mussel removal.
- Dewatering provides an opportunity for testing protective coatings.

Disposal and odor problems
Potential problems: Large quantities of decaying mussels could cause odor problems.

Potential solutions:

- Fans may be helpful in the work area. The idea of rapid removal, prior to decay, was discussed.

Bulkhead slots

Potential problems: An accumulation along the slots or sealing surfaces could cause closure problems. However, the expectation is that the weight of bulkheads is adequate to clear the slots and crush any mussel accumulation on the seals.

Potential solutions:

- Some field experience is needed before suggesting specific actions. For example, a mock bulkhead or other cleaning method can be designed if necessary. Periodic cleanings during the growth season probably would keep the slots clear of mussels and associated debris.

Navigation aids

Buoys and trash booms

Potential problems: Large accumulations of mussels have been observed on buoys, cables, and chains. The extra weight and drag force can cause these devices to sink.

Potential solutions:

- Early detection, by placing reference lines on buoys and floating objects, was suggested. Towboat operators can be expected to report sinking of buoys. Project operators should regularly observe the conditions of trash booms and similar floating devices.
- Greasing cables will prevent mussel attachment. However, for environmental reasons, some districts have a policy of not greasing underwater equipment.
- Buoys can be periodically removed and dried to eliminate accumulations.
- In heavily infested areas, an inspection of cables by divers could be warranted.

Mooring bitts

Potential problems: Clusters of mussels can prevent free movement of floating bitts. The mussels could attach to either the submerged bitt elements or to the slot below lower pool.

Potential solutions:

- Mooring bitts usually can be raised, tied off, and dried, permitting detection and removal by hosing or scraping.
- The bitts can provide a suitable environment for testing protective coatings.
- Some districts already have heaters on floating devices; heating will destroy zebra mussels.

Ladders

Potential problems: Since no large buildup of mussels are expected between lower and upper pool, the ladders should not be a problem. Corps personnel are discouraged from using the ladders from a dewatered lock chamber.

Submersible racks and gates

Trash racks

Potential problems: Racks having large bar spacings (6-inch is common) and regularly exposed to high velocity flow, such as at lock culvert intakes, are unlikely to accumulate large numbers of zebra mussels. When accumulation does occur, then unbalanced flow, excessive loadings on the bars, corrosion, and slower operation can occur.

Potential solutions:

- A program of operation can be instituted for rarely used locks.
- Anti-foulant coatings may be worthwhile at rarely used locks.
- Removable screens can be raised, cleaned, and replaced. Many racks and screens are not removable. Cable screens, for example, would probably need a crane operator for removal.
- A doughnut shaped scraper will be helpful for cleaning bars.
- Other topics (heating strips, hot-tip galvanizing) were also mentioned.

Wicket-type gates

Potential problems: Wicket-type gates remain in a set position for several months and could be an ideal location for zebra mussel development. To maintain pool, the wickets are up to form a damming surface. At open river stages, the wickets lay on the bottom and, if not properly seated, can swing up and be damaged by propeller wash. If eye bolts become infested or if tracks become clogged, misoperation could occur. Other concerns, relating to extra weight during raising and blockage during closure, were discussed.

Potential solutions:

- Early detection could require a substrate or structural element to be inspected by diver.
- These structures are not easily cleaned if infestation is severe. For example, two pieces of floating plant are needed to move a wicket. Information on experiences will be helpful and communications between districts and projects is encouraged.

Special devices

Air vents

Potential problems: New locks on the Ohio River are designed with low culverts so that air vents are not required. Older locks and high lift locks do use air vents for the purpose of preventing cavitation downstream of culvert valves. Occlusion could possibly lead to cavitation damage.

Potential solutions:

- Early detection in the vent itself is difficult because of the small size, often about 12-inch diameter, and the tortuous path of the vent. For a lock where venting is critical for safe operation an artificial substrate could be used.
- Backflushing is not considered a viable option. A protective coating could be worthwhile. Biocides were not considered workable because contaminated water reenters the vent during each lockage. The suggested method is physical removal by pigging. A modified chimney cleaner can probably be designed to clean lock air vents if necessary.

Bubbler systems

Potential problems: The concern is that the mussels might occlude the bubbler lines. Instrumentation bubblers commonly use some form of nitrogen gas as a drying agent which is thought to be a hostile environment for zebra mussels. Bubbler systems used for ice and debris control use high-velocity air flow, which is hostile to the mussels. In addition, the mussels are dormant during the period of time that icing occurs.

Potential solutions:

- Early detection is important. Currently, it is difficult to estimate the severity of this problem.