Fisheries and Oceans Canada | Pêches et Océans Canada

Fish Screen Design Criteria for Flood and Water Truck Pumps

Fisheries and Oceans Canada

Overview

Development is ever increasing in the north, with many associated activities occurring in the winter months when access to remote locations is facilitated by seasonal winter roads made of snow and ice. The construction and maintenance of winter roads often require large quantities of water that is withdrawn from ice-covered lakes, ponds, streams, and rivers. The duration and frequency of water withdrawals for access construction is limited at a given water source compared to more permanent structures such as a municipal or permanent camp water intake.

During construction or maintenance, water is used to strengthen or repair sections of the roadway. Water can be applied to the surface of the ice road using a flood pump or a water truck. Flood pumps are used to pump water directly from an auger hole to the surrounding surface area, and are used when a larger volume of water is required and a source of water is available at the site (Figure 1). Water trucks also need to extract water though holes augured through the ice, but have the ability to transport and distribute water over a larger area including portages (overland sections between waterbodies).

Fig.1. Flood Pump and the flood pump in use.

As with any water intake that operates in fish bearing waters, protection of fish from entrainment (i.e. fish drawn into the water intake) or impingement (i.e. fish held in contact with the intake screen and cannot escape) is required. The objective of this document is to

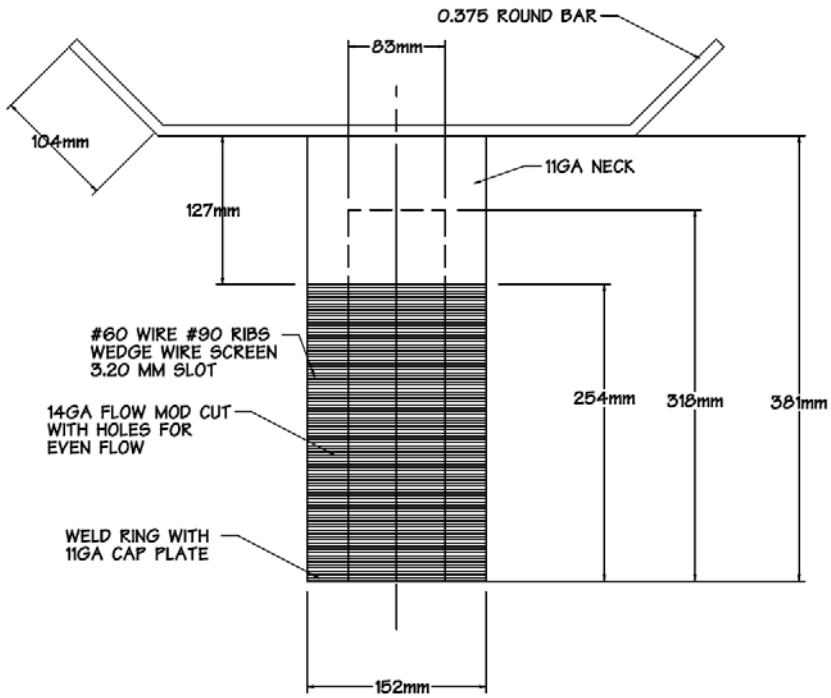
supplement the existing Department of Fisheries and Oceans (DFO) Freshwater Intake End-of-Pipe Fish Screen Guideline (hereafter "the DFO intake guideline) by providing fish screen design criteria to address the unique requirements and challenges of protecting fish at water intakes that are mobile, temporary and extract water through ice.

Design criteria for fish screens that are to be used for winter access construction need to take into consideration a number of factors including: the diameter of the auger hole, operating conditions, the potential for ice build-up and freezing of screens. The size and shape of the fish screen is constrained by the auger hole dimensions and ice thickness. The most common auger diameter used is eight inches, and ice thickness can exceed one meter.

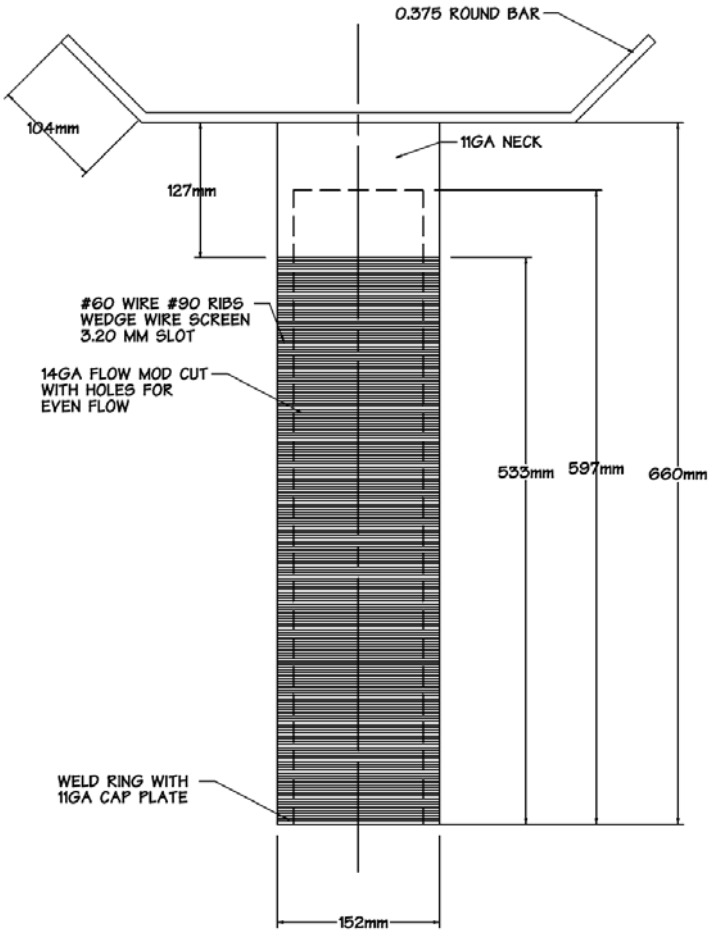
Based on a series of recent field tests of various fish screen designs, done in collaboration with DFO, the Tibbitt to Contwoyto Winter Road Joint Venture, and Nuna Logistics, the hanging basket screen design (Figure 2) with 3.20mm (0.125 inch) mesh without a baffle tube has been adopted as the design standard for flood pumps and water trucks

Fig. 2. Hanging basket screen design for water trucks (a) and flood pumps (b) © www.screen services.com. Note that baffle tubes (flow modulators) are shown in the figure but were later removed from the final design to improve pumping capacity.

a)



b)



Hanging Basket Fish Screen Design Criteria and Rational

- Design criteria aimed to balance the potential risk to fish (based on consideration that water withdrawals are typically limited and short term and are taken from ice-covered temporary water sources using small pumps) and the operating constraints of winter road operations.
- Designed for ease of use, where handling time and effort requirements are minimized to reflect the difficult and potentially hazardous working conditions (e.g. extreme cold, and isolated location).
- Fish protection is based on limiting the approach velocity in front of the intake screen to values that are within the swimming ability of fish species/ life stages likely present in

the area. Swimming ability is measured in terms of swimming speed and endurance time (the time that a fish can maintain a given swimming speed). Approach velocity is a function of the water withdrawal rate and the size (gross area) of the intake screen. The larger the screen area the lower the approach velocity.

  - The DFO intake guideline contains a summary of required screen area sizes for the two groups of fish species, anguilliform (fish that swim like eels) and subcarangiform (swim like trout) species for a range of water withdrawal rates up to 125 L/s (2000 US gpm). For more information on the approach velocity design criteria please refer to the DFO intake guideline (see link to this document under References).
  - Prototype hanging basket screens were developed for both water trucks and flood pumps and tested during the winter road field season (Table 1 and Fig. 2). Based on an assessment of the potential fish species that were at risk during the field tests, the subcarangiform group was selected as the design species. The surface area size for the screens was obtained from Table 2 in the DFO intake guideline based on the required pumping rate. The prototype basket screens were designed for 8 inch diameter boreholes.

- The hanging basket screen design was found to be most practical in terms of balancing fish protection needs with the challenges of winter water withdrawal, based on the reduced risk of entrainment and impingement due to the relatively short pumping time (less than 10 minutes at a given location), limited space between the screen and the auger hole for fish to be in, and noise levels from flood pumps which are in close proximity to where the water is being extracted acting as a potential deterrent for some fish species.

  - Both of the prototype basket screens used in testing were initially equipped with baffle tubes to ensure an even velocity distribution across the face of the screen. Testing of the flood pump with the basket screen resulted in a significant decrease in pumping capacity due to the head loss of the screen within the confines of the auger hole. The pumping capacity of the flood pump improved significantly when the baffle tube was removed from the screen. While the baffle tube did not significantly affect the pumping capacity of the water truck, the added protection to fish while the basket screen was in the auger hole was minimal and therefore it was removed.

Fig. 3. Hanging basket screen in use with water truck and flood pump.

- The recommended 3.20mm (0.125 inch) mesh size is based on a risk assessment that included fish species present and timing of the water withdrawal, location of the screens and as mitigation for potential icing effects. This differs from the design criteria for open water conditions which should use the maximum design opening recommended in the DFO intake guideline of 2.54 mm (0.10 inch) for the default 25 mm fish size.
- Screen openings may be round, square, rectangular or any combination thereof, but should not have any protrusions that could injure fish.
- The fish screen should be constructed of materials that can withstand the extreme winter temperatures and handling requirements of winter water withdrawals.
- Potential debris loading of the hanging basket screen is expected to be low because pumping time is short, the basket is positioned above the bed of the water source and sediment levels in the water column are generally lower in the winter.
- The hanging basket fish screen design could also be adapted for use in open water conditions by suspending the basket at the water surface with the use of a float or other support where water depth is sufficient to maintain the screen elevated above the bed of the water source
- **Please Note:** The recommended design where the screen is within the auger hole does not include a baffle tube. However, any proposed alternative that result in the screen being below the auger hole should include a baffle tube to produce an equal velocity distribution along the screen face to eliminate high velocity zones. A baffle tube would be required for any screen design used in open water conditions.

Table 1. Pump capacity and corresponding fish basket sizing criteria for pumps that were used during the winter road field test.

Pump Type		Pumping Capacity		Screen Size		
		L/s	US gpm	Area (m^2)	Length	Diameter
Water Truck		12.62	200	0.121	254 mm	152 mm or (6 inches)
Flood Pump		27.32	433	0.255	533 mm	152 mm or (6 inches)

Note: L/s = litres per second & US gpm = US gallons per minute

Screen Operation Criteria

- The screen should be keep clean and free of ice and debris.
- The screen should also be inspected for any damage prior to each withdrawal.
- If there is any evidence of fish impingement or entrainment the operator should immediately stop the pumping operation and relocate to a different water source.
- A second screen should be kept on hand as a backup that could be used if the primary screen is frozen due to icing or is damaged during operations.

Concluding Remarks

Properly designed fish screens for water intakes used in fish bearing waters will reduce the risk potential of injury or death to fish during the water extraction process and is a requirement under Section 30 of the *Fisheries Act*.

The hanging basket fish screen design presented in this document was developed based on the specific flood and water truck pumps used during the ice road construction field tests. The lower risk potential to fish based on the use of temporary water sources and the limited duration and frequency of water withdrawals at these sources and the operational challenges were factors in the selection of the basket screen design.

Please let us know how the screens are working as we are developing this guidance in conjunction with you, the operator. If fish are encountered, please document as much information as possible such as species, numbers, location, and water depth. Provide comments and/ or fish information to DFO by email at Bruce.Hanna@dfo-mpo.gc.ca or by phone at (867) 669-4931).

Acknowledgments

This document was prepared by Rick Gervais and Bruce Hanna, Fisheries and Oceans Canada. We would like to thank everyone who was involved in the design, construction and testing of the fish screens. In particular we would like to acknowledge Erik Madsen – Tibbitt to Contwoyto Winter Road Joint Venture; Alan Fitzgerald and the field crew from NUNA Logistics for their time, effort and commitment; Pete Cott, Fisheries and Oceans Canada and Charity Clarkin, BHP Billiton for reviewing and providing input on this guidance document; and Paul Whitham, Screen Services for designing and manufacturing the screens that were used in the field test..

References

Department of Fisheries and Oceans (DFO) 1995. Freshwater Intake End-of-Pipe Fish Screen Guideline. Department of Fisheries & Oceans Publication DFO/5080. Available at: www.dfo-mpo.gc.ca/Library/223669.pdf