Best Management Practices for Entrainment and Impingement Prevention

Introduction

§22-6A-7(e)(6) of the Horizontal Well Control Act requires that, for all surface water withdrawals identified in a Water Management Plan (WMP), an operator must:

- Identify designated uses on a stream and public water intakes proximate to the withdrawal site
- Demonstrate an adequate pass-by flow exists immediately downstream of the intake
- Specify methods of surface water withdrawal to minimize adverse impacts to aquatic life.

To streamline the WMP approval process, the Water Use section has created the technical tools in-house to fulfill the first and second bullet point requirements. While operators are currently required to detail, as part of their WMP application, their approach to minimize or prevent entrainment and impingement of aquatic life, no West Virginia guidance has been available. This document serves as a recommendation for best management practices to prevent entrainment and impingement of aquatic life at surface water withdrawal sites identified in WMPs.

Background

The protection of aquatic life at a surface water withdrawal site includes the prevention of entrainment and impingement. Entrainment is the unwanted passage of fish through a water intake, which is generally caused by an absent or inadequate screen surrounding the water intake. Impingement is the physical contact of a fish with such a barrier structure (screen) due to intake velocities which are too high to allow the fish to escape.

Both entrainment and impingement can be minimized with a well-designed intake screen structure. Simply stated, screen pore size should be limited to the extent that fish above a certain size would be physically unable to pass through. Additionally, the screened-in area should be large enough such that the approach velocity[1] of water into the intake is sufficiently low that a fish may swim to avoid the screen. When designing an intake structure which will effectively prevent entrainment and impingement, several factors must be considered including the size and species of the local fish population, the pump rate of the intake, the pore size and physical dimensions of the screen, and placement of the intake itself.

[1] The velocity component perpendicular to the screen face (rate of water moving through the screen).

Existing plans

Nationwide, several agencies have developed entrainment and impingement prevention guidelines which establish limits to the maximum approach velocity of water into the intake. Each of these plans set maximum approach velocities and maximum screen pore size. The following table summarizes various approaches.

Agency	Min. fish exclusion size (in.)[2]	Max. approach velocity (ft/s)[3]	Max. slot opening (in.)[4]	Min. % open area[5]
Susquehanna River Basin Commission (SRBC)	*Not specified*	*0.50*	*3/16" (floating intake)* *0.10" (submerged intake)*	*Not specified*
National Marine Fisheries Service (NW)	0.9	0.40 (active) 0.20 (passive)	Perforated plate: 3/32" Profile bar: 1/16" Woven Wire: 3/32"	27%
California/Oregon		0.40 (active)	Perforated plate: 3/32" Profile bar: 1/16" Woven Wire: 3/32"	27%
National Marine Fisheries Service (SW)	0.9-2.4 (fry)	0.33	Circular screens: 3/32" Slotted screens: 1/16" Square screens: 3/32"	27%
	>2.4 (fingerling)	0.80	Perforated plate: 1/4" Profile bar: 1/4" Woven Wire: 1/4"	40%
Canada	0.9	0.36 (subcarangiform) 0.12 (anguilliform)	Perforated Plate: 0.1" Wedge wire: 0.1" Woven wire: 0.1"	27%

Recommendations

It is the recommendation of the WVDEP to adopt, in part, the guidance established by The Susquehanna River Basin Commission (SRBC) as best management practices for protecting aquatic life at surface water withdrawal sites. These practices are already common to oil and gas operators working in the area under SRBC's regulatory authority. SRBC provides simple guidance which shall be easy to implement and monitor for compliance. The specific details of this plan are in good agreement with plans developed by other agencies nationwide.

[2] Threshold size of fish omitted from consideration for purposes of this study.
[3] This is the highest velocity in which fish can voluntarily swim away to avoid entrainment and/or impingement.
[4] Maximum opening for screen face material in order to prevent entrainment.
[5] Minimum open area of screen face material allowable to reduce approach velocity and prevent entrainment and/or impingement.

In addition to following the thresholds and minimum flow requirements set forth in the approved WMP, all surface water intakes should:

- Be designed to meet the demand of the withdrawal, yet minimize the overall disturbance from installation.
- Allow for complete removal of the intake and associated equipment upon completion of withdrawals.
- Be located in at least 3 feet of water, if possible.
- Include a screen with openings no larger than 0.1875 (3/16) inches for floating intake structures or 0.10 inches for submerged or buried intakes.
- Be designed to limit the through-screen approach velocity to 0.5 feet per second or less (see example calculation equation 1 below).
- Be inspected regularly and well-maintained.
- Maintain stream bank stabilization to support equipment weight and/or increased traffic.

Operators are encouraged to follow these guidelines in their WMP submittals. Deviations from these guidelines can be allowed in WMP submittals, but increased agency/operator dialogue may be necessary to ensure protection of aquatic life.

Appendix

Equation 1. What is the minimum amount of screen required to reduce through-screen approach velocity into a 2,000 gpm (2.23 cfs) pump to 0.5 ft/sec or less?

$$Approach\ velocity = \frac{Pump\ velocity}{Screen\ area}$$

$$Screen\ area = \frac{Pump\ velocity}{Approach\ velocity} = \frac{2.23\ \frac{ft^3}{sec}}{0.5\ \frac{ft}{sec}} = 4.46\ ft^2$$