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Model Tests for Traveling Water Screen at Lilley Pumping Plant

by

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Introduction

In the last decade, increasing concern for fisheries has created interest in excluding fish from water diversions with minimal impact to fish. In order to accomplish this objective, an improved understanding of fish screen hydraulics and fishery response to various conditions is needed. Resource agencies have adopted standards that require that screens meet a maximum approach velocity criteria of 0.2 ft/s in some areas. As a result, the Water Resources Research Laboratory (WRRL) at the U.S. Bureau of Reclamation (Reclamation) in Denver is currently conducting research to study the performance of various types of fish screens for shedding debris and to provide an effective positive barrier for fish exclusion. As a part of this program, A traveling water screen manufactured by Farm, Pump, and Irrigation Inc. was loaned to Reclamation for evaluation. The screen was installed in the Denver Laboratory fish test facility.

The test facility was modified to represent the Lilley pumping plant which is located on the Powder River in northeastern Oregon about three miles southeast of the town of Haines and nine miles northwest of Baker City. The Lilley plant has plans to use a traveling screen in the intake channel immediately adjacent to the existing pumping plant.

The Model

The fish screen test flume was modified to represent the sectional geometry of the proposed screen site at Lilley pumping plant including the structure left intact behind the screen and the location of the pump intake. The model was designed with full scale depth and with a screen designed to be 1/3 the width of the proposed prototype screen. The screen was installed without flights and at an angle of 70 degrees (figure 1).

Investigations

Velocities were measured at a 3-in distance from the face of the screen with an acoustic doppler velocimeter along a grid pattern spaced at 5-in increments horizontally (referenced as Quads A through D from left to right; looking downstream) and at 6-in intervals vertically, beginning 2-in below the water surface (referenced as rows 8 or 7, through 1; from top to bottom). Flow conditions were designed for a uniform flow distribution and an approach velocity of 0.2 ft/s. The pump intake flow rate corresponding to this condition was 1.2 ft^3/s with a submerged screen area of approximately 6 ft^2. The velocities measured for this condition are shown in figure 2.

A second, high-velocity test condition was also tested based on a uniform design approach velocity of 0.4 ft/s. The pump intake flow rate corresponding to this condition was 2.4 ft^3/s with a submerged screen area of approximately 6 ft^2. The velocities measured for this condition are given in figure 3.

In addition, two types of aquatic debris (Egeria and grass) were used to determine the screen's effectiveness for removing debris without flights (debris pickup bars) installed on the screen.

Results

Velocity profiles

Figure 2 shows that for the low velocity flow condition, the approach velocity distribution is fairly uniform for test rows 8 through 5 and remains below resource agency criteria. Approach velocities measured along row 4, which is the location of the only internal cross member blocking flow through the screen, are about 15% less than those measured above that location. Velocities measured below row 4, gradually increase due to the location of the pump intake near the bottom of the channel. Velocity criteria is exceeded along rows 1 and 2; therefore this profile should be considered when sizing a screen or design flow for a configuration of this type. The velocity profile for the high-velocity flow condition (figure 3) follows a pattern nearly identical to that of the low velocity condition; demonstrating a consistent pattern over a range of flow conditions. This indicates that baffles near the bottom of the screen may be an effective means for producing a more uniform flow distribution from top to bottom.

Debris Tests

Tests with debris showed that light materials such as grasses tend to stick to the screen and therefore are easily removed even with the screen oriented at a steep angle of 70 degrees. The denser Egeria had a tendency to roll off the screen and ball up next to the screen where it continued to accumulate more debris. Therefore the screen was only effective at picking up lightweight materials without the aid of flights (debris pick-up bars) added to the screen and only when the screen was not already blocked by larger debris . There was no noticeable difference between the high and low velocity condition, in the screen's ability to pick up debris; however higher velocities may help lighter materials adhere more readily to the screen.

Figure 1. Traveling water screen installed in test flume at 70 degrees.

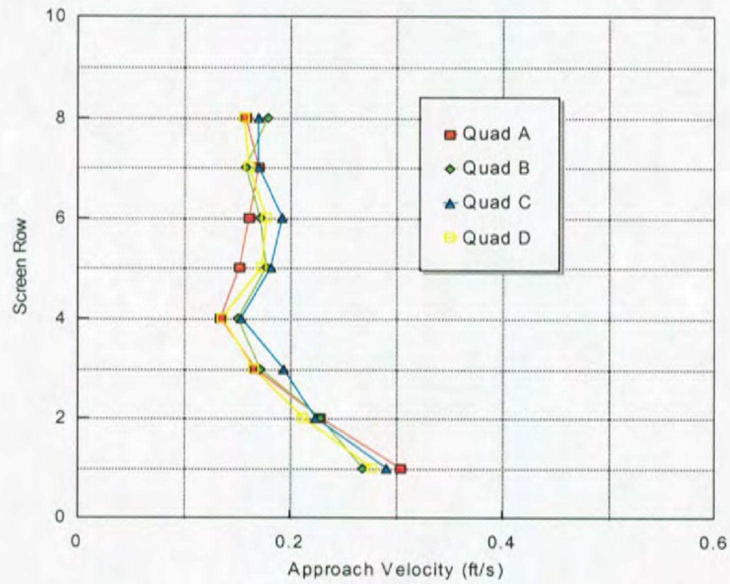

Figure 2. Traveling screen velocity profile - Low velocity flow condition.

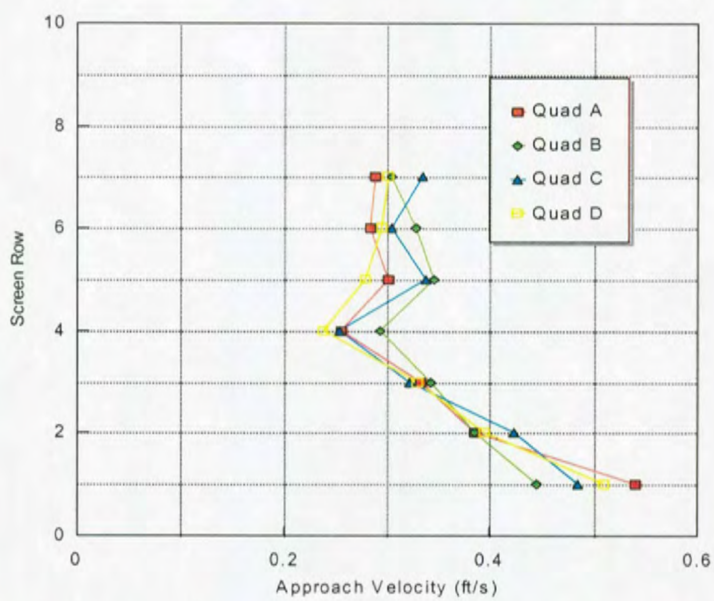

Figure 3. Traveling screen velocity profile - High velocity flow condition.