B.C. SPRINKLER IRRIGATION MANUAL

Chapter 10

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LIMITATION OF LIABILITY AND USER'S RESPONSIBILITY

The primary purpose of this manual is to provide irrigation professionals and consultants with a methodology to properly design an agricultural irrigation system. This manual is also used as the reference material for the Irrigation Industry Association's agriculture sprinkler irrigation certification program.

While every effort has been made to ensure the accuracy and completeness of these materials, additional materials may be required to complete more advanced design for some systems. Advice of appropriate professionals and experts may assist in completing designs that are not adequately convered in this manual.

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10 DIVERSIONS AND INTAKES

Withdrawing water from a surface water source for an irrigation system often requires a diversion and intake system. The construction of the diversion and intake must be such that downstream water demands and fishery resources are not impacted. In all instances diversions and intakes should be constructed to prevent fish from entering the intake or diversion channel. While it is impossible to indicate all the various methods of diverting water into an irrigation system, this chapter provides some diversion and intake options.

10.1 Diversions

Diversion structures are used to divert water away from a stream or river into an irrigation channel or piped inlet of the irrigation system. The type of diversion selected will depend on the size of the creek or river, the amount of water being diverted, whether the irrigation system is gravity fed or pumped and whether there are fish present in the stream.

Small Creeks

If the creek is small enough, a diversion structure can be constructed within the creek bed. Figure 10.1 indicates a small diversion structure utilizing stop logs to divert the flow into the irrigation system intake. The maximum stop log height should not exceed 12” as the creek should be allowed to flow over the diversion. The structure should be built to allow for fish passage and should be constructed in a manner that minimizes the disturbance of the stream bed and banks. The irrigation intake pipe is often set directly into the pool upstream of the diversion structure.

Small gabions can be used in place of stop logs if required. Gabions are compartmented rectangular containers made of heavily galvanized steel wire woven in a uniform hexagonal triple twist pattern with an opening of approximately 75mm by 225 mm. Gabion structures will settle, adjust themselves to foundation settlement, and seal up over time. If they are used as a diversion structure, they must be sealed initially. Gabions are constructed in the following manner:

1. For easy handling and shipping, gabions are supplied folded into a flat position. They are readily assembled by unfolding and by simply wiring the edges and the diaphragms to the sides.

2. The gabions are filled to a depth of one foot, and then one cross tie is placed in each direction and looped around the meshes of the gabion wall. This operation is repeated until the gabion is filled.

3. Adjoining gabions are wired together by their vertical edges; empty gabions stacked on filled gabions are wired to the filled gabions at front and back.

4. After the gabion is filled, the top is folded shut and wired to the ends, sides and diaphragms.

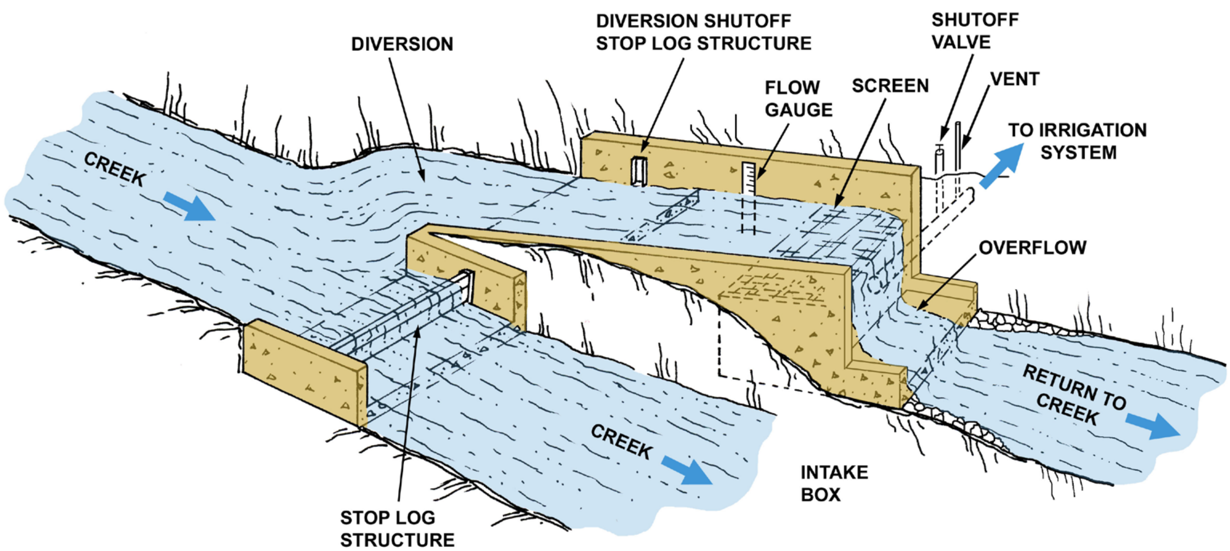

Figure 10.1 Stop Log Diversion Structure

Small Rivers

If it is not possible to withdraw water directly from a creek, water must be diverted into a side canal or lagoon for delivery to an irrigation system. A 90^o diversion will attract less debris into the intake. Figure 10.3 indicates a method of diverting water to an irrigation channel or an irrigation intake. If possible the dredged area in the middle of the channel should be large enough to create a pool to help settle out debris. This area can then be cleaned to periodically to keep the intake free of debris. The screen used to prevent material from entering the channel will need to be sized as per the guidelines in Section 10.3 if fish are present.

Settling basins are often required for diversions from streams with high silt content. The water velocity must be reduced to 0.5 ft/sec or slower to allow sand and silt to settle out. Settling basins can easily be 20 m to 40 m in length depending on the type of material suspended in the water. The configuration of a settling basin will depend on site specifics. Figure 10.2 shows a small concrete settling basin with trash rack and intake pipe. Costs for this type of intake can be quite costly and may only be practical for large intake systems.

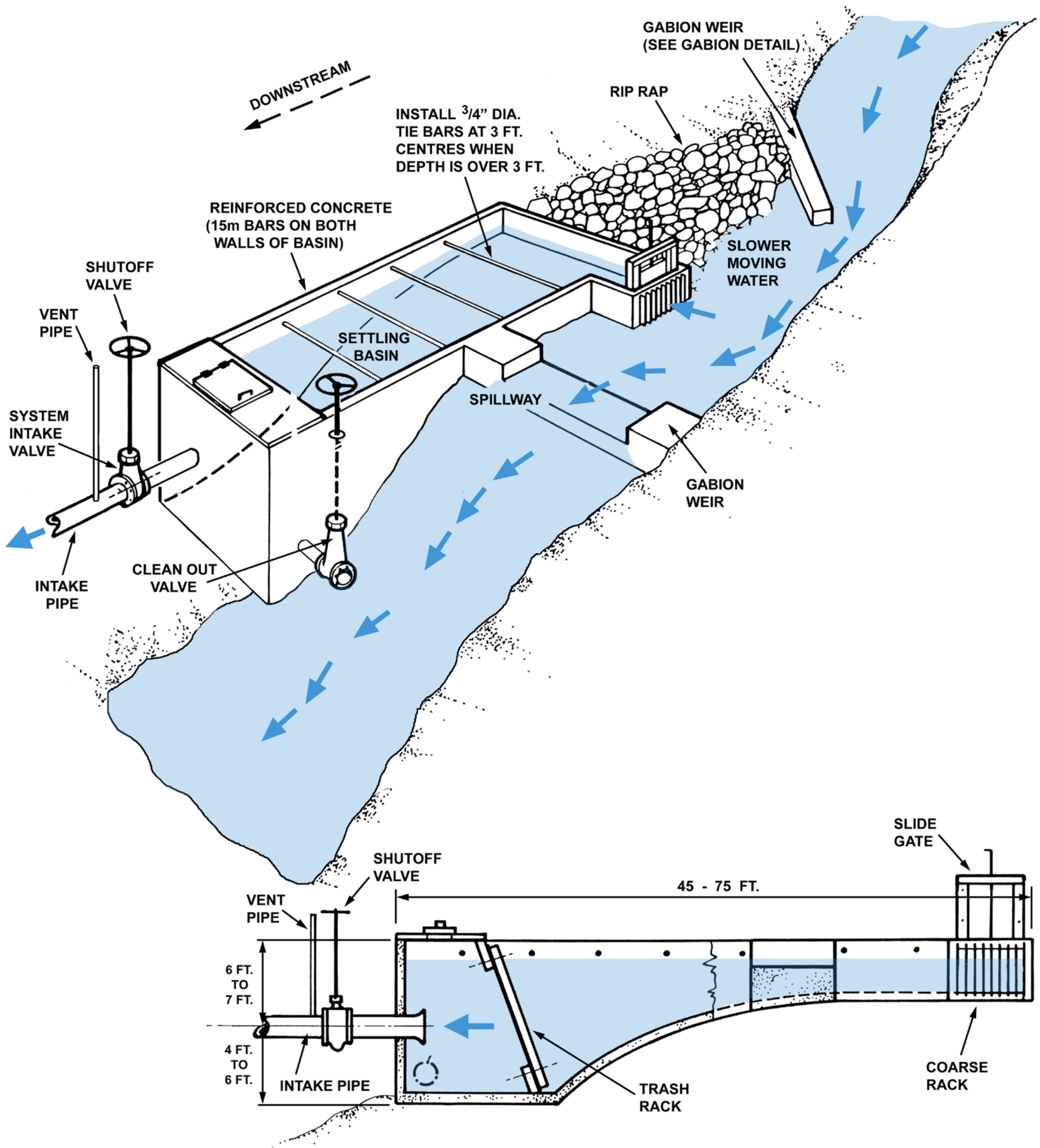

Figure 10.2 River Diversions Using a Settling Basin

Source: Small Hydropower Handbook

10.2 Intakes

In British Columbia, the mountainous terrain often allows for gravity feed systems to provide the pressure required to operate an irrigation system. Intakes for gravity feed systems have special requirements.

Gravity Feed Intake

The diversion from a surface water source into a gravity feed intake should have flow velocities less than 0.30 m/sec (1ft/sec). Flow velocities can be reduced by first diverting the water into a ditch or small reservoir prior to the water entering the irrigation mainline.

Air vents should be installed on the pipeline close to the intake, and should be vented above the entry point to the pipeline. See Figure 10.3. An air vent can simply be a standpipe open to the atmosphere which extends above the water surface level. This insures that air can be supplied to the line should the intake become blocked. A 2-inch air vent should be an adequate size for most systems with intake pipes less than 12 inches.

The top of the intake pipe should be positioned to ensure that it is below the water surface at all times. To prevent air from entering the system, the following formula can be used to determine the minimum submergence depth of a pipe.

Equation 10.1 Minimum Submergence

$$H = \frac{0.0622 \times Q^2}{D^4}$$

where

H = Minimum submergence [in]
Q = system flow rate [US gpm]
D = pipe diameter [in]

For example, the minimum submergence required for a 10" irrigation intake at various flow rates is listed in Table 10.1.

Table 10.1 Minimum Submergence Requirement

Flow Rate [US gpm]	Height (H) [in]
1,000	6
1,500	14
2,000	25

Note that doubling the flow changes the submergence by a factor of four times.

Figure 10.3 indicates a simple gravity feed intake. The trash rack bars should consist of 1/4" x 1" steel bars welded to 1/4" x 2" mounting bars, with a 3/4" space between bars. The clear opening between the trash rack and the pipe inlet should be greater than twice the actual pipe diameter. The flow velocity at the intake should be limited to 1 ft/second at the trash rack.

Example 10.1 Sizing Trash Rack

Question: What size trash rack is required to limit flow velocity to 1 ft/s for a 1,000 gpm flow rate? The open area for the trash rack is 75% (1/4" steel bars with ¾" spacing between bars).

Information:

Flow rate (Q)	1,000	1	US gpm
Flow velocity (v)	1	2	ft/s
Percent open area	75	3	%

Calculation:

Equation

$$\text{Area (A)} = \frac{Q}{v}$$

$$= \frac{1{,}000\ [1]\ \text{gpm}}{1\ [2]\ \text{ft/s}} \times \frac{1\ \text{ft}^3}{7.48\ \text{gal}} \times \frac{1\ \text{min}}{60\ \text{sec}}$$

$$= 2.23\ [4]\ \text{ft}^2$$

Equation

$$\text{Area (A)} = \frac{A}{\text{Percent Open Area}}$$

$$= \frac{2.23\ [4]\ \text{ft}^2}{75\ [3]\ \%}$$

$$= 3.0\ [5]\ \text{ft}^2$$

If the height of the intake area is limited, a sloped trash rack can be used to increase the area without increasing the height (see Figure 10.5). Trash collected on the screen or trash rack can then be easily removed or raked onto the access platform for disposal.

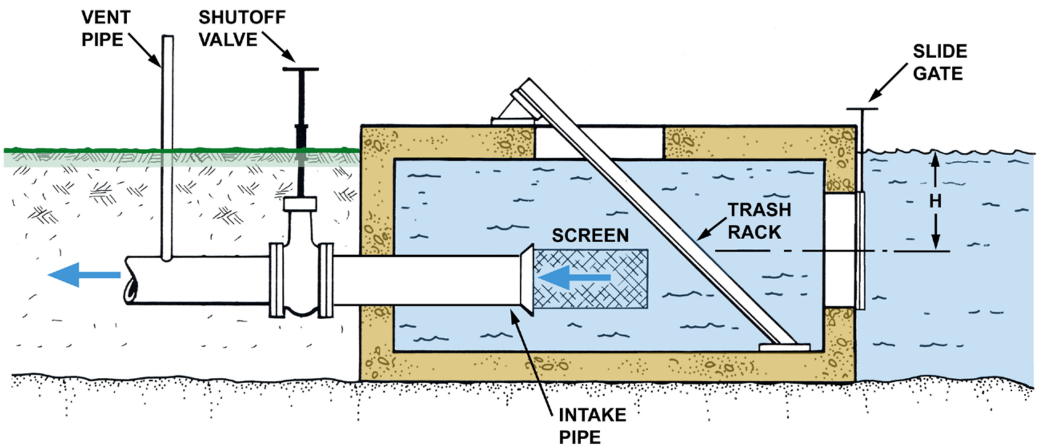

Figure 10.3 Sloping Trash Rack

Pump Intake

Centrifugal pumps are the most common type of pumps for irrigation systems with pumping requirements less than 60 hp in British Columbia. Where higher horsepower units are required or where elevation lifts are excessive vertical and submersible turbines are often used.

Figures 10.4 and 10.5 illustrate methods of installing an intake screen for a centrifugal pump on creeks or lakes. The type of intake used will depend on the water depth and lake or creek bottom profile.

A flexible rubber hose system in the suction system allows the intake to adjust for different water elevations. An airtight connection must be maintained to prevent air from entering the suction pipe.

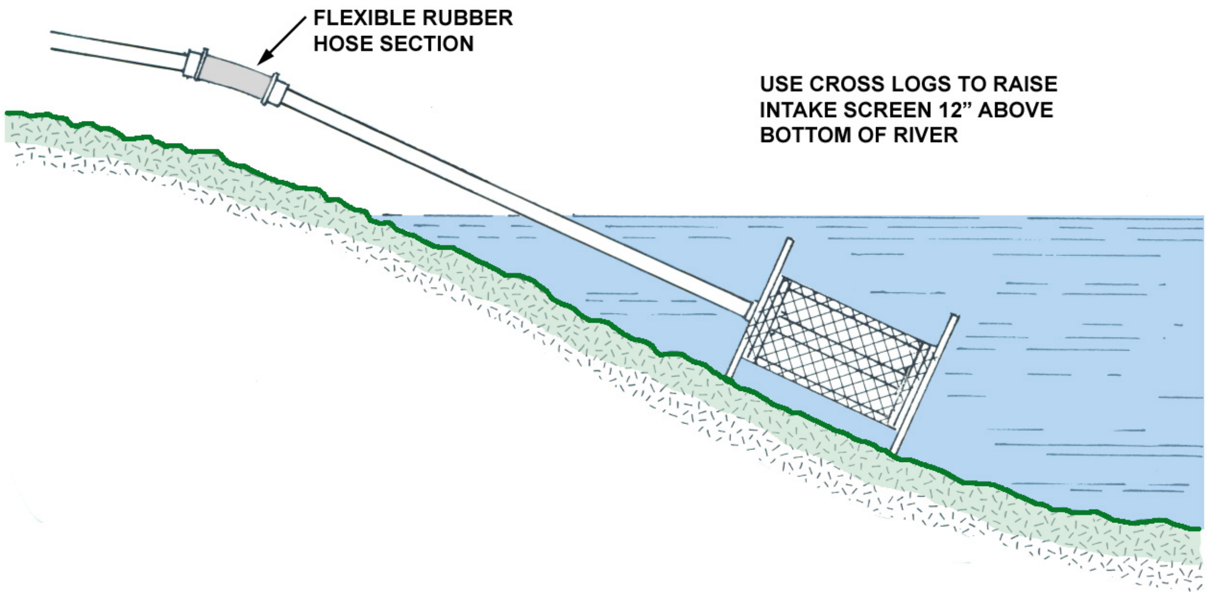

Figure 10.4 Standard Centrifugal Pump Intake

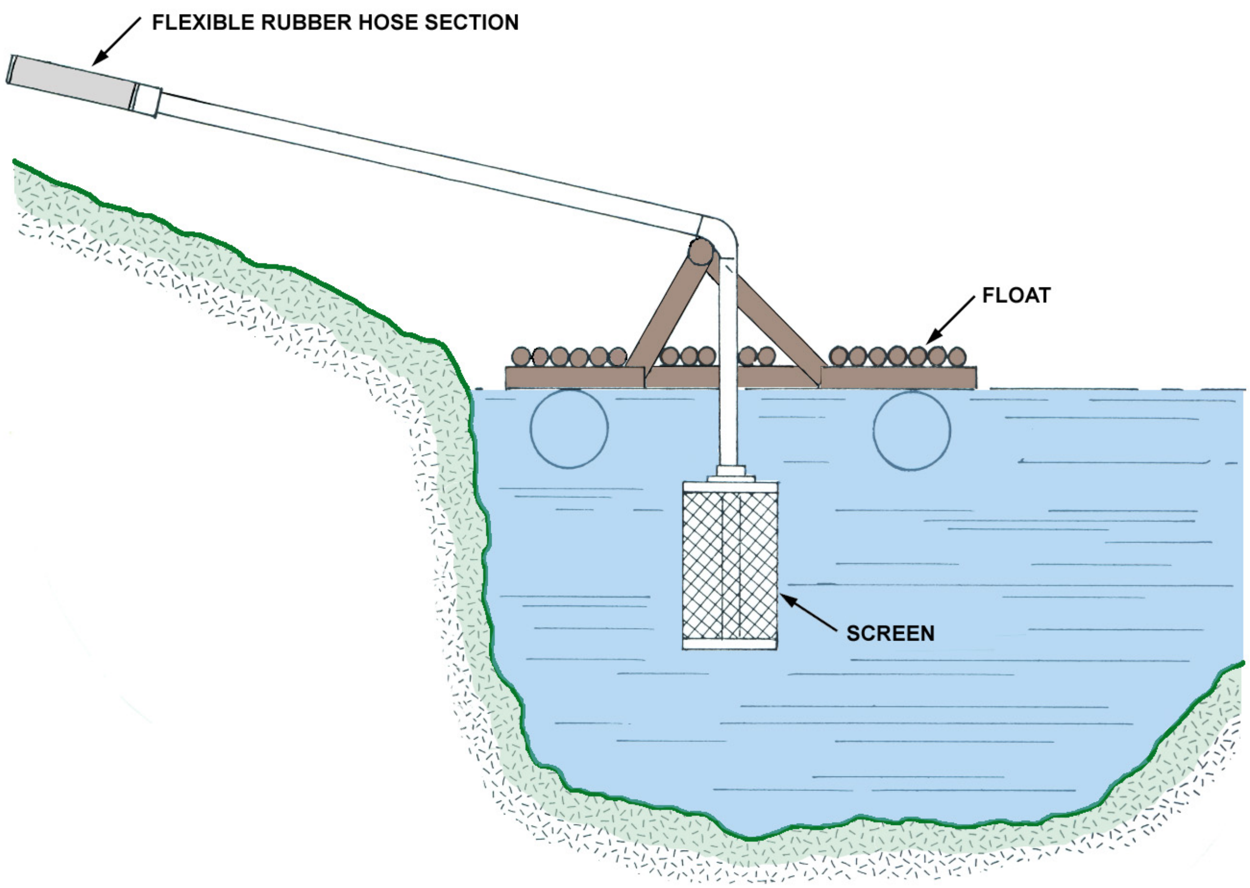

Figure 10.5 Centrifugal Pump Intakes for Deep Water Installations

Self-cleaning intakes are also available. There are two types. The first type of self-cleaning intake uses a set of spray nozzles to rotate the screen (Figure 10.6). The second type uses a rotating bar with spray nozzles inside the intake (Figure 10.7). With both types the purpose is to spray away the debris that may build up on the outside of the screen.

Figure 10.6 Rotating Self-Cleaning Intake

Source: Sur-Flo

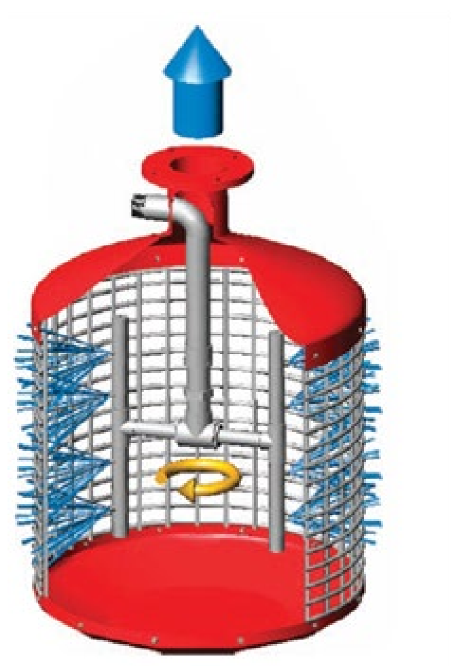

Figure 10.7 Non-Rotating Self-Cleaning Intake

Source: Waterman Industries – Self-Cleaning Intake Strainer WRS Series

10.3 Screens

When drawing water from lakes or rivers, a screen is often required to keep debris from entering the irrigation system. A trash rack may be used to prevent large obstacles from damaging the screen, but screens are necessary to remove any obstacles that are large enough to plug the sprinkler orifice.

An irrigation system withdrawing water from a fish bearing stream or lake must restrict the flow velocity through the screen to 0.1 ft/sec. The percentage of open area of the screen must be established and taken into account when calculating the screen area required. Table 10.2 can be used as a guide in determining the screen open area required.

Table 10.2 Screen Area Required for Fishery Regulations

Flow Rate [US gpm]	Screen Open Area [ft^2]
50	1.11
100	2.23
150	3.34
200	4.46
300	6.69
400	8.92
500	11.10
1,000	22.30

Table 10.3 indicates the opening area for standard market grade wire mesh. This mesh wire cloth is available in brass, aluminum, bronze, stainless steel and numerous other alloys. Fisheries recommendations suggest screen mesh sizes with clear openings that do not exceed 0.10 inch and open screen areas that are not less than 50% of the total screen area.

Table 10.3 Opening Area of Standard Market Grade Wire Mesh

Mesh	Wire Diameter		Width of Opening		% Open Area
	[in]	[mm]	[in]	[mm]	
3 x 3	0.080	2.03	0.253	6.42	58%
4 x 4	0.063	1.60	0.188	4.78	56%
6 x 6	0.035	0.889	0.132	3.35	63%
8 x 8	0.028	0.711	0.096	2.44	60%
10 x 10	0.025	0.635	0.074	1.88	55%
12 x 12	0.023	0.584	0.060	1.52	52%

Source: C & E Mesh Products Ltd.

Example 10.2 Sizing Intake Screen

Question: The wheeline system in Armstrong is pumping from an active fish stream. What size of intake screen is required? Screen mesh opening cannot exceed 0.10 inch. The velocity requirement for a screen in fish-bearing streams is 0.1 ft/sec.

Information:

Total flow rate (Q)	693	1	US gpm

Since screen mesh opening cannot exceed 0.10 inch, the following should be selected:

Velocity (v)	0.1	2	ft/s
Mesh (Table 10.3)	8 x 8	3	
Percent open area (Table 10.3)	60	4	%

Calculation:

(1). To calculate the screen size, the pump flow rate (Q) needs to be converted to cubic feet per second.

Equation

$$\textbf{Area (A)} = \frac{Q}{v} \times \frac{ft^3}{7.48\ gal} \times \frac{1\ min}{60\ sec}$$

$$= \frac{693\ [1]\ gpm}{0.1\ [2]\ ft/s} \times \frac{1\ ft^3}{7.48\ gal} \times \frac{1\ min}{60\ sec}$$

$$= 15.4\ [5]\ ft^2$$

Equation

$$\textbf{Area (A)} = \frac{A}{\text{Percent Open Area}}$$

$$= \frac{15.4\ [5]\ ft^2}{60\ [4]\ \%}$$

$$= \boxed{25.7\ [6]}\ ft^2$$

A rectangular screen that is 2 ft high, 3 ft wide and 2 ft deep would be adequate if the screen was suspended in the stream and all six sides are exposed. If one side of the intake is sitting on the bottom of the stream then the dimensions would be a bit larger.

A gravity feed intake often requires a large screening surface and one that is self-cleaning. Figure 10.8 indicates a relatively simple method to accomplish this. Variations of this culvert screen system are possible.

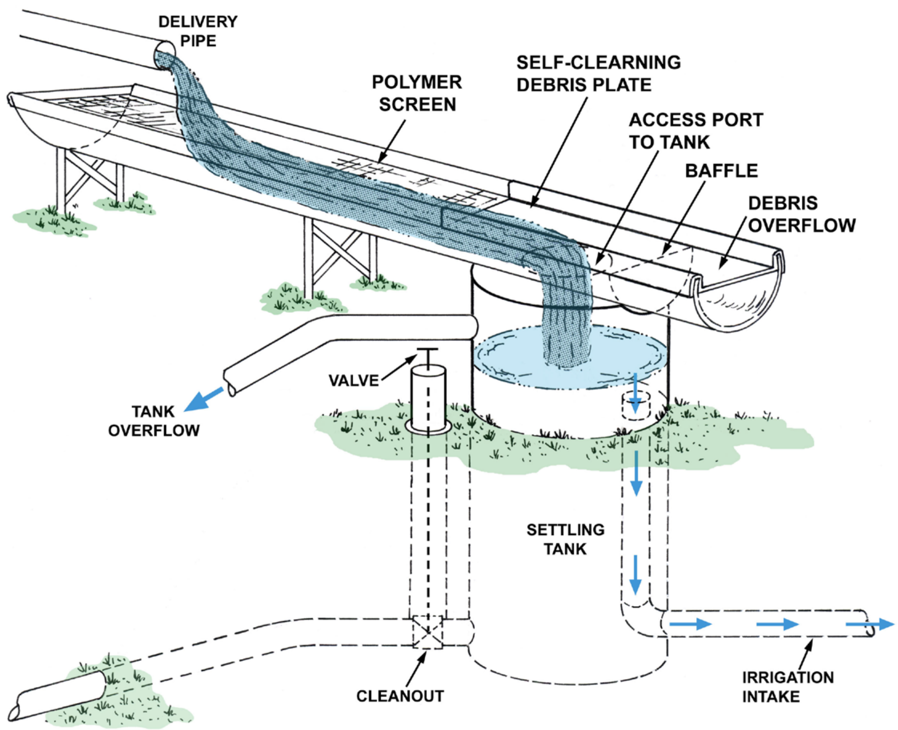

Figure 10.8 Self-Cleaning Screen for Gravity Intake

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