

Tide Gates Glossary

There is very little information available anywhere related to tide gates and flap gates. This is a glossary of terms that are associated with, or useful when discussing, tide gates. Some are terms that I have personally coined. Others are simply obscure or have important subtle meanings that may not be obvious.

If you have comments on this or suggestions for other terms that should be added to this glossary, please send an e-mail to Jeff.Juel@JuelTide.com.

Aberdeen Tide Gate – The hydraulically controlled side-hinged flap gate originally designed by Jeff Juel in 1993. This tide gate was first installed in Aberdeen Washington in 1995 as part of the USACE's South Aberdeen and Cosmopolis Flood Control Project.

Armoring - A layer of stone or other suitable material placed in the stream to protect the banks from erosion. High flow during extreme events can create scour conditions that are normally addressed with armoring. If the armor stones are exposed on low tides, fish leaving with the ebb flow may be injured when dashed against the rocks.

Back Flow (or back flush) – Water flowing from the tidal end of a flap-gated culvert towards the protected side of the levee. Back flow also occurs during the flood tide in free-running sloughs, rivers, and creeks that discharge into tidal estuaries. Traditional flap gates do not allow back flow.

Backwater – A rise in the water level upstream of an obstruction or constriction in the channel.

CDF – Control Density Fill. A lean concrete mix with high slump. CDF is an excellent material to use to fill the void beneath the haunches of a culvert. It flows between the corrugations of corrugated pipes and reduces the possibility of piping beneath the culvert. The culvert should be in a dewatered trench and must be prevented from floating when CDF is placed. CDF can be placed very quickly – which is important when working without a cofferdam and using low tides to place and backfill a culvert.

Check Dam – See Weir.

Downstream – Away from the protected side of the levee towards the receiving body of water. During back flow, water at a fish-friendly flap gate flows upstream.

Draft Force – The force imposed on the gate leaf by water flowing past an open flap gate experiencing back flow. The draft force is proportional to the submerged area of the gate leaf and increases with the velocity of the flow. The draft force grows geometrically with a rising downstream water level.

Ebb Tide – A falling water level caused by the tide. The ebb tide carries water toward the sea.

Ebb Channel – The channel leading from a tide gate, slough, or creek to open water during low tide. When the tide is low, the flow from a tide gate may have a long flow path in an ebb channel crossing extensive tidal flats. If the conveyance capacity of the ebb channel is insufficient, a backwater curve and tail water can persist at the discharge from the tide gate. This can significantly impair the ability of the tide gate to pass runoff during low tides.

Ebb Jet – The concentrated flow that passes down the ebb channel during an ebb tide.

Estuary - A partly enclosed coastal body of water with one or more rivers or streams flowing into it, and with a free connection to the open sea.¹

Fish Friendly Flap Gate – A flap gate that facilitates fish passage and allows some tidal flushing without allowing flooding.

Fish Friendly Tide Gate – A tide gate that opens wide to facilitate fish passage and allows some tidal flushing without allowing flooding.

Flap Gate – The generic name for a simple one-way valve attached to a culvert or headwall. May be top-hinged or side-hinged. Flap gates may discharge into water that is not tidally influenced.

Float-controlled Flap Gate – A flap gate that closes during backflow when the upstream or downstream water level is high enough to lift the float that controls a mechanism of some kind.

Flood Tide – The rising water level caused by the tide. During low river flow, tides may cause water to move from the sea into the estuary and up river.

Gate Leaf – The part of a tide gate or flap gate that physically covers the culvert, preventing back flow.

Head Cutting – Upstream migration or deepening of a stream channel that results from erosion of the stream channel due to high water velocities. When the deepening migrates to the head wall of a tide gate, the headwall can be undermined and topple into the scour hole. A weir slightly downstream from the head wall will retard head cutting and create a plunge pool which will dissipate energy and reduce scour caused by high flows during low tide.

Head Loss – The energy loss associated with water flowing in a culvert, pipe, or open channel. Increasing head loss in a system causes a reduction in the conveyance capacity of the system. Low head loss side-hinged flap gates pass more water than normal top-hinged flap gates.

Head Wall – A head wall can be used at either end of a culvert to retain the fill material over the culvert. A flap gate can be attached to the head wall on the downstream end of the culvert.

Hinge Tube – A tube with pivot pins on the ends that the gate leaf is secured to on a side-hinged flap gate. The hinge tube is set slightly out of plumb so that the tide gate will close in standing water if the tension regulator is disconnected.

¹ Wikipedia

Tide Gate Pond – When the tide is up and the flap gate is closed, stream flow arriving at the flap gate will form a pond immediately upstream from the closed flap gate. The culverts should be sized such that the maximum zero-damage pond can drain completely on a typical lower low water tidal cycle.

Riffle – A very shallow and wide weir usually made of stone that lies just below the surface of the ebb channel.

Rigging – Wire rope, connectors, and a “tension regulator”. The rigging is configured to apply a moment about the hinge axis of the flap gate – effectively opposing the draft force.

Rootwad – A length of tree trunk and root mass placed in the stream with the trunk buried into the bank and the root mass extending out into the water. Anchored rootwads located downstream from a tide gate on the banks of the ebb channel can be used to prevent large woody debris from migrating to the tide gate during backflow.

Salt Wedge – Salt water is more dense than fresh water. If the water at an estuary is stratified, on a rising tide the incoming salt water will form a wedge beneath the fresh water coming down the river.

Scour Hole – High flow exiting a culvert during an extreme low tide can create a scour hole immediately downstream from the culvert.

Seating Head – When the water level downstream from a closed flap gate is higher than the water level on the upstream/protected side, the differential is known as the seating head.

Self Regulating Tide Gate (SRT) – A top-hinged flap gate that allows some tidal backflow. A design known as an SRT was originally patented by Waterman Industries.

Side-Hinged Flap Gate – A flap gate that is hinged on the side.

Slough – Dictionary definition: “A stagnant swamp, marsh, bog, or pond, especially as part of a bayou, inlet, or backwater.” (They are only stagnant if they’re behind an old-fashioned flap gate.) A slough is a natural shallow drainage channel running through a flat lowland area subject to tidal flows.

Swinging Log Boom – A log boom located downstream from a tide gate. A segment of the boom swings open to allow debris to pass on the ebb tide. This segment closes to prevent debris from approaching the tide gate on the flood tide.

Tension Regulator – The device that controls the rate that the tension in the rigging increases as the rigging elongates when a VBFG-equipped tide gate closes.

Thalweg – The deepest part of a channel. During low tide, a wide ebb channel with a small gradient and a shallow thalweg does not convey as much flow as a channel with a deeper thalweg.

Tidal Flushing – In a natural estuary, the rising and falling tide causes water to fill and drain the estuary as well as the sloughs and lower reaches of the rivers and creeks that discharge into the estuary.

Tidal Pulse – The volume of water that travels up and down a creek or slough with the rising and falling tide. Traditional tide gates eliminate the tidal pulse upstream from the tide gate and reduce the flow downstream from the tide gate.

Tide Gate – A water control device that prevents backflow through a culvert and discharges into a tidally-influenced body of water (frequently an estuary). Most tide gates are simple flap gates. A dike or levee without any tide gates is a reservoir.

Trash Rack – A metal grate on a culvert inlet that prevents floating debris from fouling a tide gate. Trash racks require regular maintenance and debris removal. If the tide gate allows back-flow, upstream and downstream trash racks may be required. If the tide gate opens wide, most debris will simply hang up at the end of the culvert or pass through the culvert including the flap gate. Other measures can be used to control the movement of floating debris (log booms) and trash racks may not be necessary.

Trip Elevation – The desired water level at which the tide gate closes on a flood tide. The trip elevation can be an interior water level or a water level downstream from the tide gate. On the flood tide, the difference in water level upstream and downstream is at most a few inches and the difference from one tide to the next is very small - for most sites. Debating about the pros and cons of using the upstream water level or downstream water level is pointless – unless there is a substantial amount of head loss at the tide gate when the water level reaches the trip elevation.

Tuning – Setting the rigging so that the VBFG™-equipped tide gate operates as desired. Tuning entails: 1) selecting the un-stretched length of the tension regulator; 2) setting the spring constant for the tension regulator; and 3) setting the tension in the rigging when the tide gate is fully open during a rising tide. A properly tuned VBFG™ tide gate: 1) closes consistently at the desired elevation; 2) Does not slam shut; 3) opens fully later during the falling tide when the seating head is minimal; 4) does not cause the tension regulator to be over-stressed when the tide gate is closed.

Upstream – Towards the protected side of a levee at a flap gate. Water may flow in the upstream direction through a culvert if backflow is allowed at the flap gate.

Variable Backflow Flap Gate (VBFG) – A patent-pending design for a side or top-hinged flap gate. The control mechanism operates based on the draft force acting on the open flap gate during backflow. The flap gate can be set so that it closes under very little backflow - or it can be set so that it only closes when the culvert is submerged and experiencing high velocity flow – or any amount of flow in between. The “trip elevation” at which the tide gate closes will not vary by more than an inch or two for a given setting of the control mechanism.

Vent – A vertical riser pipe located behind a flap gate can be used to vent a culvert and dissipate pressures caused by water hammer.

Water Hammer – The dynamic pressure wave that occurs in pipe-full flow when a valve is closed rapidly. Water hammer pressures can be substantial and cause catastrophic culvert and/or valve failure.

Water Quality – The dissolved oxygen level, water temperature, and contamination level in a water sample. During low runoff periods, the water quality upstream from traditional flap gates and tide gates degrades over time.

Water Chemistry Discontinuity – The water quality and salinity may be dramatically different upstream and downstream from a traditional flap gate. This discontinuity may prevent fish from passing the flap gate – even if they physically could transit the flap gate.

Weir – A small dam made from concrete, rock, or logs that water flows over. Weirs act as grade control structures and arrest head-cutting. Weirs can be used to provide a pool and reduce the culvert outfall height at the end of a culvert during low tides. A pool for fish to drop into rather than falling onto a rip rap apron is beneficial.

Wing Walls – A wall constructed at an angle to each side of the head wall to prevent fill material from entering the stream/river. The banks of the channel at each end of a culvert must be protected from erosion and prevented from sloughing into the channel. Wing walls tied to the head wall and splayed away from the channel perform this function. Driven vinyl or steel sheet pile are good options. Ecology blocks can be used, but they may be undermined by high flow and can topple into the channel.