OBERMEYER HYDRO, INC.

Ideas that hold water ™

Low Stress Fish Passage: An Innovative Approach For Medium and High Head Dams

Obermeyer Gates at USACE Mud Mountain Dam Fish Diversion Used in Conjunction with Trap and Truck Operation

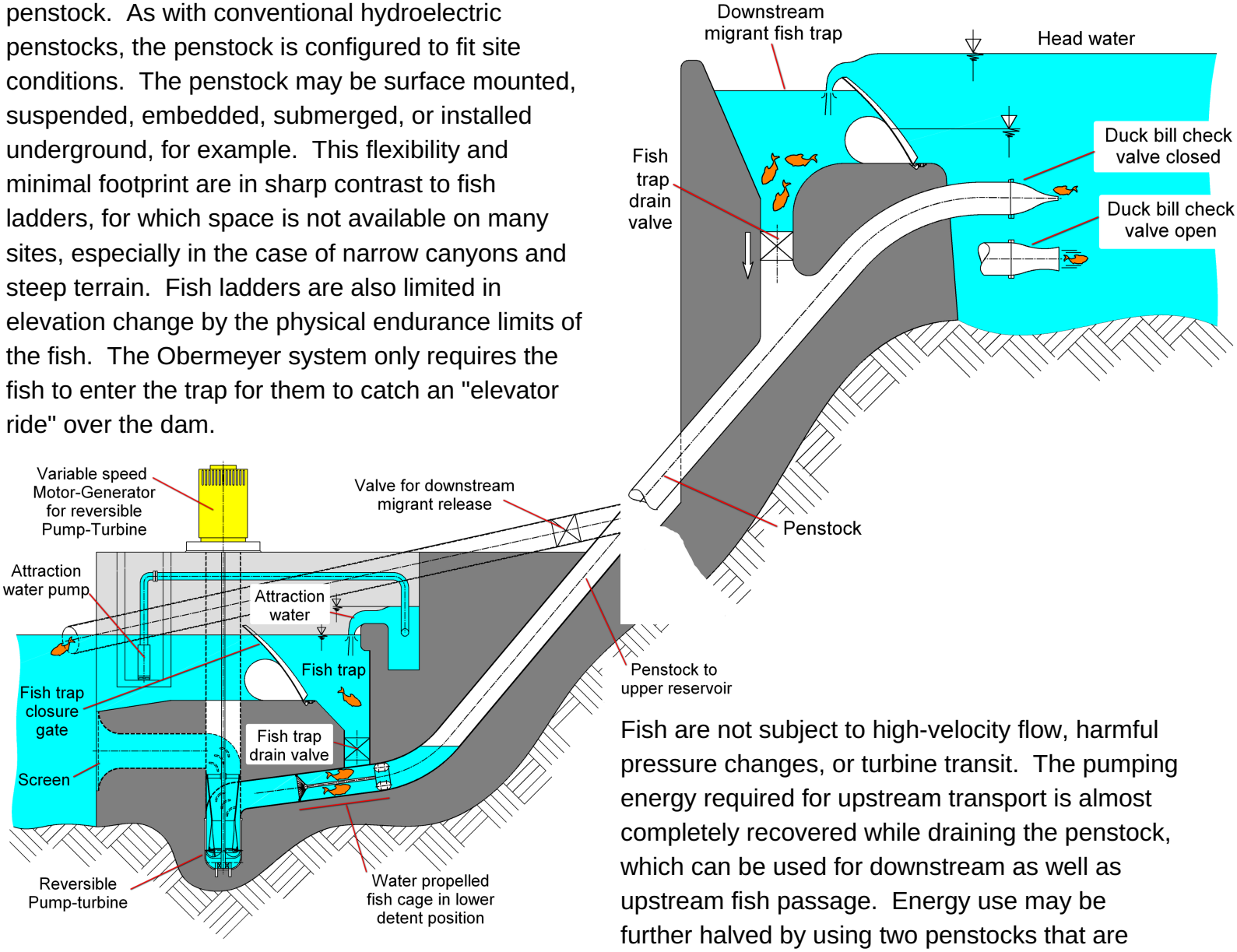
Henry Obermeyer, P.E.
President, Obermeyer Hydro, Inc.

The environmental acceptability of many existing and proposed medium and high head dams hinges on the ability to provide safe and economic passage of both upstream and downstream migrating fish. In some cases, the only available space includes areas subject to flood born debris damage, erosion, or sedimentation. The system developed by Whooshh™ Innovations is successful in transporting fish of uniform size over dams. Trap and truck operations have been successful but are expensive to operate. Mechanical fish lifts have worked where site geometry allows for a straight vertical or inclined lift of a tank.

The proposed Obermeyer system shown in Figure 1 combines pneumatically operated fish traps with a reversible pump-turbine for gently raising and lowering the water column in an auxiliary penstock between tailwater and headwater. Upstream migrating fish begin their ride by being drained from a fish trap at tailwater elevation down into a penstock. A water-propelled crowder keeps them away from the pump-turbine and at the top of the water column, which remains at atmospheric pressure during transit between tailwater and headwater elevations and vice versa.

This fish trap and auxiliary penstock may be designed into a new dam or retrofitted to an existing dam. Alternatively, the fish trap can be installed in conjunction with an existing but repurposed penstock. As with conventional hydroelectric penstocks, the penstock is configured to fit site conditions. The penstock may be surface mounted, suspended, embedded, submerged, or installed underground, for example. This flexibility and minimal footprint are in sharp contrast to fish ladders, for which space is not available on many sites, especially in the case of narrow canyons and steep terrain. Fish ladders are also limited in elevation change by the physical endurance limits of the fish. The Obermeyer system only requires the fish to enter the trap for them to catch an "elevator ride" over the dam.

Figure 1



US and Foreign Patents Pending

Fish are not subject to high-velocity flow, harmful pressure changes, or turbine transit. The pumping energy required for upstream transport is almost completely recovered while draining the penstock, which can be used for downstream as well as upstream fish passage. Energy use may be further halved by using two penstocks that are alternately filled and emptied by the pump-turbine located at the lower end of the penstocks. The pump-turbine associated with the fish passage system may also be used for increased and efficient hydropower generation during non-fish passage seasons.

Obermeyer Gates Used For Head Water Following Fish Ladder

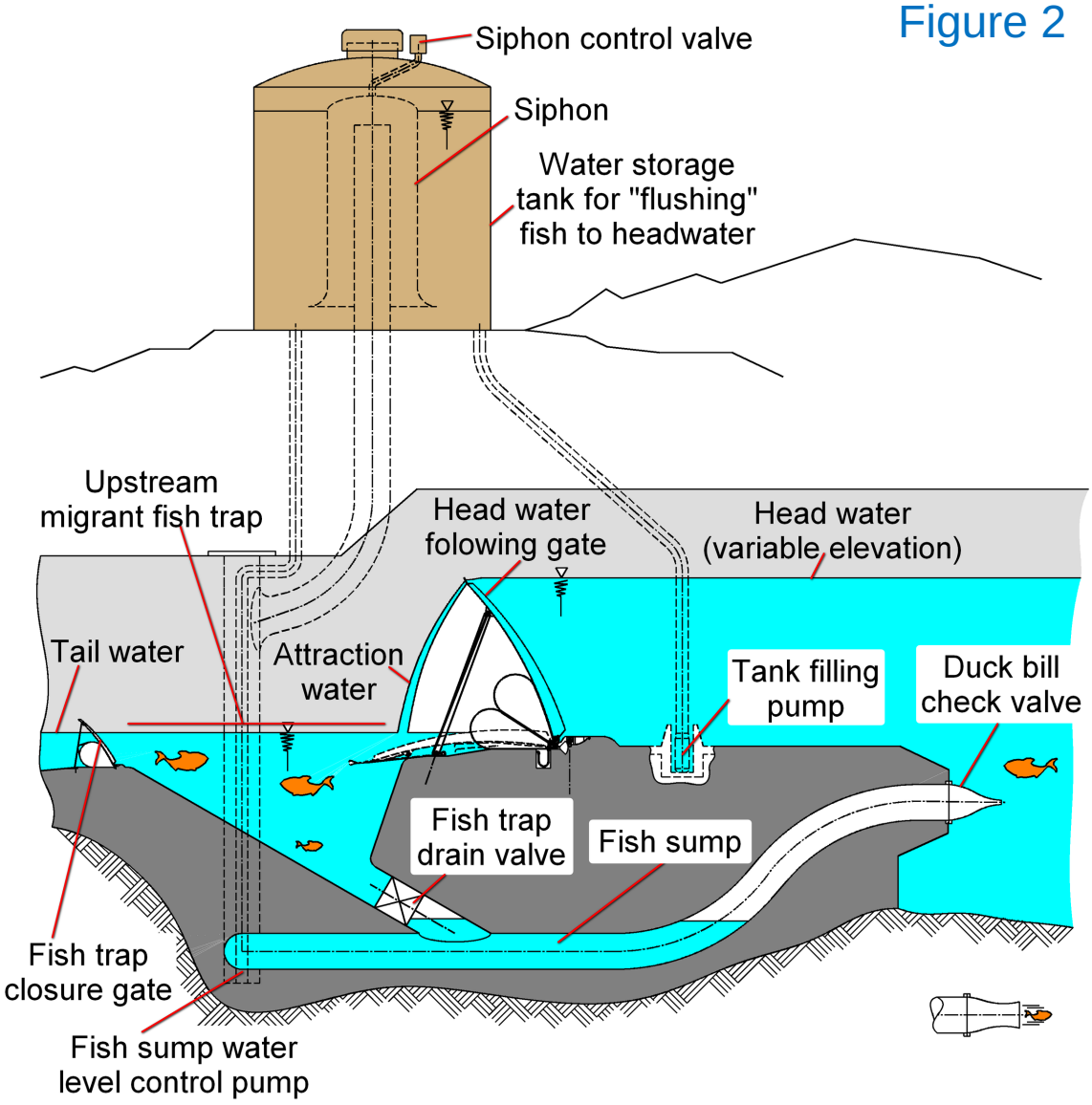
For downstream fish transport, fish may be trapped downstream of a headwater-elevation-tracking Obermeyer gate, and then periodically drained with their surrounding water into the penstock just upstream of the crowder. The fish and their supporting water column are then lowered down the penstock at speeds controlled by the reversible pump-turbine. As the water in the penstock drains, the reversible pump-turbine recovers almost all the energy used for pumping. The downstream migrating fish are thus provided a safe and obstacle-free ride to tailwater with negligible pressure change. The position within the penstock of the downstream migrating fish is constrained during transport on the upstream side by the free water surface at atmospheric pressure and on the downstream side by the crowder screen. As the fish approach tailwater, the pump-turbine brings the flow through the penstock to a gentle stop with the crowder precisely positioned by a detent in the penstock. A bottom outlet valve on the penstock is then opened to drain the fish into a chute that guides them into the tailwater. With the fish no longer in the penstock, the crowder detent is released, and the water level in the penstock is reduced to below tailwater elevation utilizing an auxiliary pump. This action allows the next batch of upstream migrating fish to be lowered into the penstock and floated to the upper reservoir.

The fish may exit the upstream end of the penstock above water level, or if below water level through a flexible duckbill valve, for example. Detents in the penstock prevent the crowder from being expelled into the upstream reservoir with the fish. The reversible pump-turbine speed is adjusted in proportion to the square root of the head to maintain the best efficiency, as the water is drained back out of the penstock

The system illustrated in Figure 1 is capable of transporting fish many hundreds of meters in elevation while keeping the fish very near atmospheric pressure. In the case of the upstream passage of fish, a pump supplies attraction flow into the fish trap.

The system may be adapted to low head fish passage, as shown in Figure 2, where the small footprint and ability to pass a variety of species efficiently is advantageous. For low head sites, energy recovery is of less consequence, and the reversible pump-turbine(s) are omitted. Upstream migrating fish are first trapped upstream of an Obermeyer gate. The water in the trap, along with the fish, is dropped into a sump below the tailwater level. No particular behavior of the fish is required – the fish and their surrounding water are moved by gravity. Water stored in a tank above headwater is flushed through a siphon, carrying fish from the sump below the fish trap to the headwater. Downstream passage would generally not need to be incorporated into such a system because downstream passage at low head facilities can readily be accomplished with a combination of open channel chutes and fish-friendly turbines.

Figure 2



US and Foreign Patents Pending