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The Mid Columbia Total Dissolved Gas TMDL: Balancing Compliance with Other Demands

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The Washington Department of Ecology and the U.S. EPA recently developed a Total Maximum Daily Load (TMDL) for total dissolved gas (TDG) on the Mid Columbia River from the Canadian Border to the mouth of the Snake River. Elevated TDG has long been a problem in the Mid Columbia River, and the major source of TDG is spills from dams on the Columbia River and its tributaries. Spills entrain air and carry it to depth, where pressure forces the air into solution producing supersatured TDG levels.

Dams spills occur when river flows exceed the capacity of the hydroelectric turbines. This can occur due to the magnitude of spring freshet flows, because turbines are unavailable due to maintenance or repair, or because of a lack of market for the power. Columbia River dams also provide spill for juvenile fish passage, which improves survival of endangered salmonid stocks.

State water quality standards for TDG are set at 110% saturation to prevent gas bubble disease in fish. Special criteria at higher levels have also been established for fish passage spill. These criteria balance the higher survival rate of juvenile out migrants who pass the dam by spill (instead of through the turbines) with the deleterious effects of higher gas levels in the spill, while keeping the risk to juvenile salmon low. The TMDL has been written to ensure compliance with both the 110% criteria and with fish passage criteria through management of spill.

Compliance with the TMDLs depends on a variety of factors. The amount of TDG generation from spill is usually a function of dam configuration, spill way and powerhouse operation, spill volume and tailwater elevation. Therefore compliance with the TMDL is tied to structural changes to reduce TDG generation (such as spill deflectors), maximizing power generation, and minimizing spill.

The ten dams downstream of Grand Coulee Dam are all “run-of-the-river” dams – their storage capacity is extremely limited, so they are required to pass virtually all upstream flow. So with power production maximized, and given the existing structure and operations, TDG generation becomes a function of system-wide management of flow.

The Columbia River is a highly regulated system. Storage dams in the headwaters of the basin – in Idaho, Montana, Washington State, and Canada – are managed to control flows for a variety of purposes, including power production, flood control, fish and wildlife, cultural resources, recreation, and water quality. Managing flows to minimize TDG involves balancing these purposes.

One key to TDG management is to minimize peak flows. In general this is exactly what flood control rule curves are designed to do. However in practice flood control targets the minimization of extremely high flows, and the consequence is the emptying of reservoirs to provide storage. Often the emptying of reservoirs produces high enough flows to result in uncontrolled spill and elevated TDG. Better real-time operational tools might be able to reduce the amount of spill that produces high TDG, but there are two major constraints. First, there is great resistance to any changes to operational rules that increase the statistical probability of downstream flooding. Second, operations of Canadian flood control dams are governed by international treaty, which make change very difficult.

A variety of proposals have been under evaluation for providing optimal seasonal flows for fish habitat, and these sometimes balancing fish needs with TDG management. The VARQ proposal seeks to modify reservoir seasonal draw-down and refill management at Libby, Hungry Horse, and Grand Coulee Dams to provide flows for protecting endangered sturgeon and salmonid species. However, changes to flood control operations might change the timing and magnitude of downstream flows. This in turn might increase the frequency of spills that raise TDG above standards. These issues are under consideration as part of the development of an Environmental Impact Statement for VARQ.

Other proposals have been made to adjust flood control curves to allow increased summer flows for flow augmentation and temperature control. Again, operations that increase the volume of water available in the summer may also increase the probability of spills that exceed TDG above standards.

As this paper illustrates, balancing flow management to implement a TDG TMDL with other flow management objectives presents complex challenges.