State of Oregon
Department of Environmental Quality Memorandum

Date: Jan. 27, 2015

To: Environmental Quality Commission

From: Dick Pedersen, Director

Subject: Agenda item A, Action item: Request from U.S. Army Corps of Engineers for a modification to the total dissolved gas water quality standard on the Columbia River for fish passage
Feb. 2, 2015, EQC special meeting

Why this is important

This is an action item for total dissolved gas water quality standard modification from 110 percent to 120 percent to allow voluntary spill that will aid fish passage at mainstem Columbia River dams. Releasing water over a dam's spillway is a fishery-management tool on the Columbia River. However, spilling water over dams increases the level of total dissolved gas in the river. Water plunging from a spillway traps air and carries it to a depth where the pressure forces the gas into solution. Total dissolved gas levels above 110 percent of saturation can cause gas bubble trauma in fish.

In 1976, Oregon adopted the U.S. Environmental Protection Agency's total dissolved gas criteria of 110 percent of saturation. The 110 percent total dissolved gas standard protects beneficial uses of the Columbia River, and protects aquatic life, such as endangered and threatened salmon and trout salmonid species.

The U.S. Army Corps of Engineers is requesting a modification to Oregon's 110 percent total dissolved gas water quality standard. The standard modification will allow voluntary spilling of water at Bonneville Dam, The Dalles Dam, John Day Dam and McNary Dam along the Columbia River to assist fish passage of out-migrating salmon and trout salmonids.

Background

The voluntary spill program is designed to improve fish passage past the dams while minimizing risk from total dissolved gas.

<u>Fish migration</u>
In order to survive, juvenile fish must be able to migrate downstream past the Columbia River dams. Turbines at these hydro electric dams hinder migration, so water is deliberately spilled from McNary, John Day, The Dalles, and Bonneville Columbia River dams to improve fish passage. This is commonly referred to as voluntary fish passage spill. These spills, however, increase total dissolved gas in the river to levels greater than the water quality standard of 110 percent.

When total dissolved gas levels are too high it can harm migrating juvenile and

adult salmonids by causing gas bubble trauma, similar to the bends in humans. However, fish can obtain relief from the affects of high total dissolved gas by diving to compensation depth. Total dissolved gas above 100 percent is reduced by approximately 10 percent per meter depth.

Balancing spills and total dissolved gas for fish survival

The incidence of gas bubble trauma in salmon smolts due to fish passage spill is estimated at 1.1 percent when total dissolved gas levels are managed to 120 percent below the dam in the tailrace. This estimate is based on smolt monitoring data collected from 1995 through the 2014 seasonal spill period. The estimated 1.1 percent observation of gas bubble trauma is not an indication of severity and does not directly translate to mortality; however, it does indicate a low risk of mortality from gas bubble trauma.

Historically, fish passage spill has been managed to a total dissolved gas limit of 115 percent in the forebay upstream of the dam and 120 percent downstream of the dam in the tailrace. DEQ removed the forebay upstream limit in 2009 by a departmental order based on the findings of the adaptive management team and expects this to be protective of migrating salmonids during voluntary fish passage spill (http://www.ecy.wa.gov/pubs/0910002.pdf). Washington Department of Ecology retained the 115 percent requirement for the forebay. In bi-state waters the stricter regulation takes precedent. Therefore, the U.S. Army Corps of Engineers has continued to operate spill to comply with both the 120 percent tailrace limit and the 115 percent forebay limit.

When the in-river total dissolved gas levels are below 120 percent, few, and in some cases no, migrating fish display signs of gas bubble trauma. Since 1.1 percent is a low incidence of gas bubble trauma and because spills result in increased salmon survival, a modification from strict adherence to the 110 percent standard allows for the benefits of spill, which outweigh the risk from total dissolved gas.

Historical choice of voluntary spills

EQC has granted standard modifications to the US Army Corps of Engineers for total dissolved gas since 1994. Current Oregon Administrative Rule language, established in 1995, allows EQC to approve modifications to the total dissolved gas standard. EQC granted the modifications because of the low incidence of gas bubble trauma and the effectiveness of voluntary spill for fish passage. NOAA Fisheries has identified voluntary spill as the safest, most effective tool available for improving downstream smolt survivorship.

2014 Supplemental Federal Columbia River Power System Biological Opinion (2014 Biological Opinion)

National Oceanic and Atmospheric Administration National Marine Fisheries

Service issued its 2014 Biological Opinion on Jan. 17, 2014. The opinion states whether a federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat. The Biological Opinion requires voluntary fish passage spill at Columbia River dams to support fish migration even when it results in total dissolved gas super-saturation above the state's 110 percent standard.

The U.S. Army Corps of Engineers is currently operating in accordance with the 2014 Biological Opinion Reasonable and Prudent Alternative actions. The previous 2008 Biological Opinion concluded that the risk associated with a managed voluntary fish spill up to the 120 percent total dissolved gas level is warranted by the projected increase in system survival of juvenile salmonids. The 2014 Supplemental Biological Opinion relies on DEQ to make the determination of what the range of total dissolved gas would be for the modified standard.

Alternatives to voluntary spills

Voluntary fish passage spill is a low risk method of improving downstream fish passage at mainstem Columbia River dams. Structural modifications at the dams, such as instillation of removable spillway weirs, have improved smolt passage at spillways. Depending on the dam and species, spill passes approximately 52 to 88 percent of juvenile salmonids. Structural modifications have also improved survivorship through turbines. However, spill has greater survivorship. Table 1 shows passage and survival data collected in 2010-2012. The U.S. Army Corps of Engineers, U.S. Bureau of Reclamation and Bonneville Power Administration reported this information in the 2013 Comprehensive Evaluation, which address requirements of the Biological Opinion. Because most salmonid smolt pass via the spillway, survivorship is expected to be lower when the voluntary spill program is operated at 110 percent total dissolved gas than when operated at 120 percent.

Table 1. Range of passage and survival averages for steelhead and yearling and subyearling Chinook salmon at lower Columbia dams in 2010-2012.

	Route	Bonneville	The Dalles	John Day	McNary
Passage	Spillway	52 - 58%	66 - 88%	63 - 78%	73 - 83%
	Turbine	25 - 30%	5 - 17%	4 - 12%	2 - 9%
Survival	Spillway	93 - 97%	96 - 100%	92 - 99%	95 - 99%
	Turbine	93 - 96%	86 - 93%	80 - 91%	73 - 96%

The goal of barge and truck transport of juvenile salmonids is to increase the portion of fish returning as adults to spawn. The Independent Science Advisory

Board and NOAA Fisheries continue to support transport in conjunction with spill to spread the risk of negative outcomes due the different types of passage. However, transportation is associated with greater likelihood of adult straying, in which adults do not return to spawn in their natal streams. Straying inhibits recovery of endangered and threatened salmonid species. The experience of in-river migration contributes to genetic adaptation of the species to altered conditions.

The Biological Opinion incorporates hatcheries as a means of supplementing salmonid numbers until the species can sustain itself. The presence of in-stream migrating hatchery smolts reduces the amount of wild smolts subject to predation and mitigates a portion of wild smolts lost to turbines or other causes during dam passage. However, hatchery fish can compete with wild fish for food and habitat and interfere with the wild fish's genetic adaptation to its environment.

Voluntary spill and involuntary spill

The draft EQC order will affect voluntary spill, which is conducted by the Corps for the purpose of improving juvenile salmonid migration. The draft order will not affect involuntary spill resulting from factors outside the Corps' control. These factors include high flows that exceed the capacity of a dam to either temporarily store water upstream of the dam or pass the water through the turbines. As a result, water must be released as spill. Involuntary spill can also occur due to passing debris, turbine unit outages, transmission outages, required operational and maintenance activities, and lack of power demand limiting flow through turbines. Exceedances of the 120 percent modified standard have, largely, resulted from involuntary spill conditions.

Factors leading to exceedances during voluntary spill include hydrologic and water quality conditions that do not align with forecasted variables such as flow, water temperature and wind. The Army Corps of Engineers uses a model, SYSTDG, to help manage spill for total dissolved gas levels on a system-wide basis. The system includes the Columbia River from Grand Coulee Dam to Bonneville Dam, the Snake River from Lower Granite Dam to the confluence with the Columbia River, and from Dworshak Dam on the Clearwater to its confluence with the Snake River. SYSTDG is statistically evaluated annually and recalibrated when structural changes, which affect total dissolved gas levels, are made to a dam in the system. Although the Army Corps of Engineers conduct long term and short term forecasting of total dissolved gas, quickly changing environmental conditions that are not reflected in model simulations can lead to total dissolved gas exceedances. However, exceedances due to voluntary spill are rare and typically exceed the modified total dissolved gas water quality standard by small percentages for a short duration.

Terms of most recent EQC order

The most recent EQC order allowed fish passage spill April 1 through August 31 at Bonneville, The Dalles, John Day and McNary dams. The order requires physical monitoring of total dissolved gas below the dam in the tailrace with a limit of 120 percent measured as the 12 highest hours in a day, biological monitoring of gas bubble trauma in fish during the spill period and annual reporting to DEQ.

Total Maximum Daily Load allows spills

In 2002, Oregon and Washington issued a Lower Columbia River total dissolved gas total maximum daily load that was approved by EPA. The total maximum daily load allows fish passage spills until 2020 with a provision that operational and structural modifications that reduce total dissolved gas generated during spill must be in place by that time. The goal of the total maximum daily load is to meet the 110 percent total dissolved gas state criteria while allowing for voluntary fish passage spill.

The U.S. Army Corps of Engineers operates the dams and is responsible for implementing the operational and structural modifications identified in the total maximum daily load.

Request to renew the Total Dissolved Gas Standard modification

On April 4, 2014, DEQ received a request from the Army Corps of Engineers, with support from NOAA Fisheries, for a modification to the state's total dissolved gas standard. The most recent EQC order, which modified the total dissolved gas standard, was issued in 2009 for a five-year period and expired at midnight Dec. 31, 2014. The last day the modification was in continuous effect for spill assisting juvenile salmonid passage was Aug. 31, 2014. The requested five-year modification must be in place by April 1, 2015, to provide spill for the next fish passage season. A summary of the full request and supporting information is included as attachment B.

Public input

Public comment received

DEQ initially issued a public notice on Sept. 10, 2014, opening a 30-day public comment period. DEQ reopened the public comment period on Jan. 5, 2015, for a 21-day period to allow time for additional comments on TDG-related information presented during the Jan. 8, 2015, EQC meeting. No new entities submitted comments although commenter 3 and commenter 5, indentified below, provided additional comments.

DEQ received six comment letters from:

1. U.S. Environmental Protection Agency
2. Bonneville Power Administration
3. Northwest RiverPartners
4. Pacific Northwest Generating Cooperative Power

5. Oregon Department of Fish and Wildlife
6. State, Federal and Tribal Fishery Agencies Joint Technical Staff Memo, signed by:
    - Columbia River Inter-Tribal Fish Commission
    - Oregon Department of Fish and Wildlife
    - Washington Department of Fish and Wildlife
    - U.S. Fish and Wildlife Service
    - Colville Tribe

Each of the comment letters received stated support for approval of an EQC order for total dissolved gas standard modification.

Specific comments include:

- Extend the continuous effective period of the standard modification to include March to assist kelt and Spring Creek Hatchery outmigration and September to assist adult migration.
- Increase limit in the tailrace from the proposed 120 percent to 125 percent.

Response to comments

DEQ believes the requirement of advance notification and approval provides the U.S. Army Corps of Engineers with adequate flexibility to access the modified total dissolved gas standard outside the April through August seasonal spill period. However, DEQ will work with the U.S. Army Corps of Engineers to develop a standard notification procedure and identify monitoring expectations to reduce the administrative burden of the notification process.

DEQ does not agree that the 125 percent limit should be considered at this time. To consider a higher modification, DEQ must conduct a thorough evaluation of information supporting 125 percent, consider information from various stakeholders and seek input from other agencies to contribute to the scientific evaluation of 125 percent. The evaluation must consider risks to salmonids in addition to resident biological communities. Detailed physical and biological monitoring plans must also be submitted for review by DEQ.

The full response to comments document is included as attachment C.

Future management of total dissolved gas

Adaptive management through multi-agency collaboration

Implementation of the Lower Columbia River Total Dissolved Gas TMDL will continue. Oregon and Washington may request further studies to determine additional structural and operational gas abatement actions that can be feasibly implemented to reduce total dissolved gas.

Total Maximum Daily Load for Lower Columbia River Total Dissolved Gas
Implementation of the TMDL will expire in 2020. Information indicates that total dissolved gas TMDL implementation efforts are not successful for meeting TMDL allocations for the four lower Columbia River dams operated by the Corps. These dams are not expected to meet the 110 percent total dissolved gas water quality standard during voluntary or involuntary spill events. However, the Corps has implemented all TMDL-identified structural modifications addressing total dissolved gas that do not also harm fish. There are no structural options remaining that were identified from TMDL implementation planning. The TMDL stakeholders will meet regularly to evaluate post-2020 regulatory options. Considerations include allowing additional time for implementation of nonstructural options.

DEQ recommendation

DEQ recommends that EQC grant the total dissolved gas standard modification as requested by the U.S. Army Corps of Engineers with the following change:

1. Include an adaptive management component as specified in the 2002 Lower Columbia River total dissolved gas total maximum daily load. Adaptive management will be used in the long-term implementation of the total maximum daily load. The adaptive management team may request further studies, and redirect or accelerate structural and operational gas abatement activities. The goal of the total maximum daily load is to meet the 110 percent total dissolved gas criterion while allowing for voluntary fish passage spill.

DEQ supports EQC approval of a five-year order. Prior to 2003, EQC annually considered approval of the total dissolved gas standard modification. The commission approved multi-year modifications beginning with the order affecting the 2003-2007 seasonal spill seasons. The EQC's approval was based on past results of biological and physical monitoring showing no significant adverse impacts on fish survival.

The EQC order affecting the 2010-2014 spill season and the draft order include safety measures allowing the DEQ director to halt the spill program if the gas bubble trauma action criteria are met and the commission to terminate or modify the order at any time. Use of real-time total dissolved gas data during the voluntary spill season is used for managing the voluntary spill program to assure total dissolved gas levels do not exceed the standard. In addition, the Corps provides an annual report to the DEQ director that is reviewed by DEQ staff for evaluating the past year's voluntary spill program and would be used for making changes to the next year's voluntary spill program.

The draft recommended EQC order for total dissolved gas standard modification is presented in attachment D.

EQC action alternatives

The commission has two action alternatives:

1. Approve the request with or without DEQ's recommended modifications. To approve DEQ's recommendation, the commission must make the four affirmative findings detailed in attachment A, as specified in OAR 340-041-0104(3). These findings are:

   (a) Failure to act would result in greater harm to salmonid stock survival through in-river migration than would occur by increased spill;

   (b) The modified total dissolved gas criteria associated with the increased spill provides a reasonable balance of the risk of impairment due to elevated total dissolved gas to both resident biological communities and other migrating fish and to migrating adult and juvenile salmonids when compared to other options for in-river migration of salmon;

   (c) Adequate data will exist to determine compliance with the standards; and

   (d) Biological monitoring is occurring to document that the migratory salmonid and resident biological communities are being protected.

2. Decline the request.

Attachments

A. Oregon Administrative Rule Relating to the Total Dissolved Gas Water Quality Standard
B. Summary of U.S. Army Corps of Engineers Request to Renew the Total Dissolved Gas Standard Modification and Department Findings
C. Response to Public Comments on the Proposed Total Dissolved Gas
D. Draft Recommended EQC Order for Total Dissolved Gas Standard Modification

Available upon request

- U.S. Army Corps of Engineers' request and summary of information relative to the total dissolved gas waiver
- 2002 Lower Columbia River total dissolved gas total maximum daily load

Approved:

Division: _____

Program: _____

Report prepared by Paula Calvert
Columbia River Coordinator

Oregon Administrative Rules
Total Dissolved Gas Criteria Relative to the Main Stem Columbia River

OAR 340-041-0031 - Total Dissolved Gas

(1) Waters will be free from dissolved gases, such as carbon dioxide hydrogen sulfide, or other gases, in sufficient quantities to cause objectionable odors or to be deleterious to fish or other aquatic life, navigation, recreation, or other reasonable uses made of such water.

(2) Except when stream flow exceeds the ten-year, seven-day average flood, the concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection may not exceed 110 percent of saturation. However, in hatchery-receiving waters and other waters of less than two feet in depth, the concentration of total dissolved gas relative to atmospheric pressure at the point of sample collection may not exceed 105 percent of saturation.

OAR 340-041-0104 - Water Quality Standards and Policies Specific to the Main Stem Columbia River

(3) Total Dissolved Gas. The Commission may modify the total dissolved gas criteria in the Columbia River for the purpose of allowing increased spill for salmonid migration. The Commission must find that:

(a) Failure to act would result in greater harm to salmonid stock survival through in-river migration than would occur by increased spill;

(b) The modified total dissolved gas criteria associated with the increased spill provides a reasonable balance of the risk of impairment due to elevated total dissolved gas to both resident biological communities and other migrating fish and to migrating adult and juvenile salmonids when compared to other options for in-river migration of salmon;

(c) Adequate data will exist to determine compliance with the standards; and

(d) Biological monitoring is occurring to document that the migratory salmonid and resident biological communities are being protected.

(e) The Commission will give public notice and notify all known interested parties and will make provision for opportunity to be heard and comment on the evidence presented by others, except that the Director may modify the total dissolved gas criteria for emergencies for a period not exceeding 48 hours;

(f) The Commission may, at its discretion, consider alternative modes of migration.

Summary of U.S. Army Corps of Engineers request for a modification to the total dissolved gas standard and DEQ findings

Federal agencies providing information

The U.S. Army Corps of Engineers and National Oceanic and Atmospheric Administration Fisheries provided the necessary information for Oregon to use in processing a modification to the state water quality standard for total dissolved gas. The standard modification will be enacted through an Environmental Quality Commission approved order and an approved gas abatement plan as stated in Washington rule.

The Army Corps of Engineers is authorized under federal statutes to operate the eight mainstem projects on the lower Columbia and lower Snake Rivers to provide passage for migratory salmonids and are the focus of these total dissolved gas standard modifications. Four of the projects, Bonneville, The Dalles, John Day, and McNary Dams, are located on the lower Columbia River in both Oregon and Washington. The other four projects, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite Dams, are located on the lower Snake River in Washington. The projects operate for multiple purposes including flood control, power generation, navigation, irrigation, fish and wildlife protection, water quality and recreation. The Army Corps of Engineers operates the mainstem projects and manages the hydrosystem through its Northwestern Division and Portland District offices in Portland, Oregon, and its Walla Walla District office, located in Walla Walla, Washington.

National Oceanic and Atmospheric Administration National Marine Fisheries Service identifies and regulates activities under the federal Endangered Species Act to protect 13 species of anadromous salmon and steelhead in the Columbia River basin. Since 1992, NOAA Fisheries has prepared several Biological Opinions on operation of the Columbia and Snake hydro system which call for project spill in the spring and summer for juvenile fish passage. The spill levels needed to protect Endangered Species Act-listed fish species often exceed the Oregon and Washington water quality standards of 110 percent for total dissolved gas saturation. The Army Corps of Engineers is currently operating in accordance with the 2014 Supplemental Federal Columbia River Power System Biological Opinion Reasonable and Prudent Alternatives.

Need for the proposed EQC order

The proposed EQC order for total dissolved gas standard modification will provide regulatory consistency between federal measures to protect Endangered Species Act listed fish species and state water quality standards.

Total dissolved gas limits for the EQC order

The Army Corps of Engineers, U.S. Bureau of Reclamation and Bonneville Power Administration currently operate in accordance with the 2014 Supplemental Biological Opinion Reasonable and Prudent Alternative Action 29. The action supports spill management not to

exceed states' total dissolved gas limits or modified limits. The opinion does not recommend or identify a numeric total dissolved gas threshold for state water quality agencies to include in the EQC order or Washington rule modification for voluntary spill purposes, but rather relies on the states to make that determination.

The Army Corps of Engineers and Bonneville Power Administration will provide voluntary spill to improve juvenile fish passage while avoiding high total dissolved gas super saturation levels or adult fallback problems. Specific spill levels will be provided for juvenile fish passage at each project, not to exceed established total dissolved gas levels

To compare against the EQC order's total dissolved gas limit, the Army Corps of Engineers will calculate average total dissolve gas using the 12 highest hourly total dissolved gas readings in a day. Washington requires average calculation using the 12 highest consecutive hourly total dissolved gas readings in a day. The EQC order's calculation produces more conservative values.

Timing and location for application of proposed limits, points of compliance and reporting

The Army Corps of Engineers requests that the standard modification apply from April through August to coincide with the timespan specified in the 2014 Supplemental Biological Opinion for the fish passage spill season. Operational Biological Opinion spill for fish passage on the lower Columbia River currently begins on Apr. 10 and continues through Aug. 31.

In addition, maintenance of spillway structures may occur in the fall or winter. These actions may require spill that exceeds the 110 percent water quality standard for total dissolved gas. Also, there is a potential for Bonneville Dam special operations use of the corner collector in March for passage of kelts or Spring Creek hatchery releases, which could exceed the 110 percent water quality standard for total dissolved gas. For these reasons, the Army Corps of Engineers request a means by which the modification can be in effect outside the spill season.

Since 1994, the Commission has granted the Army Corps of Engineers a standard modification for juvenile salmonid migration. Historically, the EQC approved short term modifications for activities such as a spill study and passage of Spring Creek Hatchery releases. Since 2008, EQC orders have allowed the Army Corps of Engineers access to short term modifications provided the Army Corps of Engineers give at least seven days' notice to the Department, conduct physical and biological monitoring during the term of the modification and obtain Department approval. DEQ believes it is reasonable to continue this provision of the EQC order.

A fixed monitoring site located downstream of the aerated zone below the spillway at each dam will serve as the compliance point for the total dissolved gas total maximum daily load. The Army Corps of Engineers' total dissolved gas monitoring network includes sites on the mainstem Columbia River including the mid-Columbia projects and upstream to the international border with Canada, and the Snake River below Dworshak Dam in Idaho. Total dissolved gas is measured every hour at each monitoring site during the duration of the fish passage spill period.

The corps has submitted a biological monitoring plan. Biological monitoring will occur according to the Fish Passage Center 2009 document "GBT Monitoring Program Protocol for Juvenile Salmonids." Juvenile salmonids will be collected at Bonneville and McNary Dams once to twice a week for examination and evaluation for incidence of gas bubble trauma. The examined fish receive ranks based on severity of their symptoms. The FPC examines up to 100 juveniles per sampling day

The Fish Passage Center (FPC) conducts GBT monitoring on a 100 fish per sampling day at 6 of the 8 FCRPS dams once to twice a week depending on the dam. The number of fish observed for GBT monitoring during the fish passage spill season is balanced to provide a statistically representative sample to avoid unnecessary impacts to the species due to handling effects. ODEQ's criteria modification and the Biological Opinion influence the amount of monitoring conducted by the FPC. GBT monitoring is funded through BPA and is coordinated through a regional forum established in 1995 for BiOp operations. Monitoring parameters are established through this process.

The Army Corps of Engineers requests shifting the annual report deadline one month from Dec. 31 to Jan. 31. Moving back the deadline will allow Army Corps of Engineers staff sufficient time to quality check data, which is provided to them in early November, and prepare the annual report.

The Army Corps of Engineers provides DEQ with the annual report in a standardized report layout. DEQ is easily able to locate relevant data to evaluate and report to the Commission. The Army Corps of Engineers providing DEQ with the annual report by Jan. 31 will not cause DEQ significant reporting delays to the Commission.

DEQ findings

Because of actions associated with the 2008 Biological Opinion, a larger portion of in-stream migrants pass the dams through spill, increasing fish passage efficiency, which is the percent of all juvenile salmon passing a dam through non-turbine routes. At the four lower Columbia River dams, spill passes a larger portion of migrants than all other routes combined. Depending on the dam and species, spill passes approximately 52 to 88 percent of juvenile salmonids. Although structural and operational modifications have improved survivorship through turbines, spill has greater survivorship compared to turbine passage.

The transport of juvenile salmonids, primarily by barge, from above Snake River dams to below Bonneville Dam has occurred for over thirty years. The goal of transport is to increase the portion of fish returning as adults to spawn. The Independent Science Advisory Board and NOAA Fisheries continue to support transport in conjunction with spill to spread the risk of negative outcomes due the different types of passage. Portions of adult returns from transport versus in-river passage are dependent on factors such as species, time of year and flow conditions including spill amounts. Comparative Survival Study data from 1994 to 2009 show comparable adult returns for wild Chinook salmon smolts. In 2010, NOAA Fisheries reported that smolt-to-adult returns are generally

higher for transported fish. Transportation is associated with greater likelihood of adult straying, in which adults do not return to spawn in their natal streams. Straying inhibits the recovery of endangered and threatened salmonid species. The experience of in-river migration contributes to adaptation of the species to altered conditions. The ISAB suggested that spill should not just be considered an alternative but as a default recommendation.

The Biological Opinion incorporates hatcheries as a means of supplementing the numbers of salmonids until the species can sustain itself. The presence of in-stream migrating hatchery smolts reduces the amount of wild smolts subject to predation and mitigates a portion of wild smolts lost to turbines or other causes during dam passage. However, hatchery fish can compete with wild fish for food and habitat and interfere with the wild fish's genetic adaptation to its environment.

Data from the Fish Passage Center show a 1.1 percent incidence of gas bubble trauma in salmon smolts in the Columbia River when total dissolved gas levels are managed to 120 percent below the dam in the tailrace. The estimate of gas bubble trauma incidence is based on smolt monitoring information collected at McNary and Bonneville dams from 1995 through the 2014 seasonal spill period and John Day dam from 1995 through 1994. When the in-river total dissolved gas levels are below 120 percent, few adult fish display signs of gas bubble trauma. Investigators have observed adult tolerance to total dissolved gas and hypothesized that it was attributable to the migration depth of adult salmonids. Depth-sensitive radio tags used in adult migration studies confirmed that adults migrate at depths up to four meters and find depth compensation protection from gas bubble trauma. For every meter below the surface water, a reduction of 10 percent total dissolved gas is measured in the water column. Resident fish and aquatic invertebrates in the Columbia River downstream of Bonneville Dam were monitored by National Marine Fisheries Service from 1993 to 1998 for signs of gas bubble disease. There were no signs of gas bubble disease observed in the aquatic invertebrates examined. There was less than one percent incidence of gas bubble disease in resident fish examined in 1993 and 1995 while in 1994, 1997 and 1998 none of the fish observed had signs of gas bubble disease. Signs of gas bubble disease were prevalent in 1996 but this was a high flow year with large volumes of involuntary spill and total dissolved gas levels above 120 percent below the dams.

According to past EQC orders and the draft order, the Corps must halt the voluntary spill program if either action criteria are met: 15 percent of the fish examined show signs of gas bubble trauma in their non-paired fins, or five percent of the fish examined show signs of gas bubble trauma in their non-paired fins where more than 25 percent of the surface area of the fin is occluded by gas bubbles. Based on twenty years of gas bubble trauma monitoring, the Fish Passage Center has stated that the action criteria are not observed during voluntary spill operations, when total dissolved gas does not exceed 120 percent.

The Army Corp of Engineers adjust spill levels at the dams based on real-time monitoring of total dissolved gas and system-wide short term and long term total dissolved gas forecasting using SYSTDG, a total dissolved gas model. Members of the Technical Management Team regularly review spill and total dissolved gas monitoring data. The Technical Management Team is a technical group, including federal, state and tribal representatives, that meets weekly during the

juvenile migration period. They are responsible for making recommendations to the Army Corp of Engineers on dam operations affecting fish.

It should be noted that a 115 percent forebay limit removed by DEQ in 2009 was retained by Washington Department of Ecology. In bi-state waters the stricter regulation takes precedent Therefore, the Army Corps of Engineers has continued to operate spill to comply with both the 120 percent tailrace limit and the 115 percent forebay limit.

DEQ finds that, given the results of past gas bubble disease monitoring and the large portion of in-river juvenile salmonids migrating through spill, the modification requested by the Army Corps of Engineers strikes a reasonable balance between increased survival and the risk of mortality from gas bubble disease.

Oregon Department of Environmental Quality

Proposed Modification to Total Dissolved Gas Water Quality Standard for Mainstem Columbia River Response to Comments

September 2014 and January 2015 Comment Periods

The Department of Environmental Quality initially issued a Public Notice on September 10, 2014, opening a 30-day public comment period on the request from the U.S. Army Corps of Engineers for a modification to the total dissolved gas water quality standard at the four dams on the lower Columbia River. Written comments were due at 5:00 p.m. on October 10, 2014. DEQ received comments from six commenters during the initial public comment period.

DEQ issued a second Public Notice on January 5, 2015, reopening the public comment period for 21-days. Written comments were due at 5:00 p.m. on January 26, 2015. Although there were no new commenters, commenter 2 and 4 provided additional comments. The summary of additional comments and DEQ's responses are appended to the commenters' original comments and DEQ responses below. DEQ did not hold public hearings during the public comment periods.

1. **Columbia River Inter-Tribal Fish Commission, Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife, U.S. Fish and Wildlife Service and Colville Tribe joint letter.**

The commenters recommend granting the U.S. Army Corps of Engineers' requested total dissolved gas standard modification with an additional two months, March and September, for the modification to be in affect without requiring the Corps to provide DEQ with at least 7-day advance notice and DEQ approval. Therefore, the 120 percent modification would be in continual affect from March through September. The commenters state that applying the modification to these additional months will enable facility operators to more quickly respond to various needs for fish passage. In March, Bonneville Dam personnel begin operation of a fish passage structure, the Bonneville Powerhouse 2 Corner Collector (B2CC), when steelhead kelt count criteria are met. In September, spill can be utilized at The Dalles Dam as a tool to attract adult fall Chinook and steelhead to the north shore ladder entrance, addressing uneven passage between the north and east ladders.

DEQ Response to Comments:
DEQ believes the requirement of advance notification and approval provides the Corps with adequate flexibility to access the modified total dissolved gas standard outside the April through August seasonal spill period. The Corps installed the B2CC fish passage structure as a required action item of the 2000 Biological Opinion and implementation activity of the 2002 Total Maximum Daily Load for Lower Columbia River Total Dissolved Gas. A goal of the TMDL is to reduce total dissolved gas generation resulting from spill at the dams. DEQ believes the standard modification should be in affect according to discrete time spans for specific reasons.

However, DEQ will work with the Corps to develop a standard notification procedure and identify monitoring expectations to reduce the preparation time for notification and the time between notification and approval.

2. Oregon Department of Fish and Wildlife

Initial Comments:
The commenter recommends granting the Corps' requested total dissolved gas standard modification with changes including adding two months to the continually affective period of the modification, which is similar to the recommendation from commenter 1. Allowing the standard modification in March will allow improved survival for juvenile fish from Spring Creek Hatchery upstream of Bonneville Dam. Allowing the modification in September will allow spill to be used in greater affect to better distribute adult migration in fish ladders during periods of overcrowding at Bonneville, The Dalles and John Day dams. Additionally, with the modification in affect during March and September, higher spill amounts will improve passage of adult spawning steelhead and out migrating kelts.

The commenter also recommends increasing the proposed modification from 120 percent to 125 percent in the tailraces with an instantaneous limit of 130 percent instead of the DEQ proposed instantaneous limit of 125 percent. The commenter states that increasing the modified standard to 125 percent is consistent with the State of Oregon's recommended spill management program.

The goal of the spill management program is to improve the portion of wild Snake River spring-summer Chinook and wild Snake River steelhead smolts that return as adults. The Northwest Power and Conservation Council established a minimum range of two to six percent Smolt-to-Adult Return ratio (SAR) is needed to recover threatened and endangered salmonids. Snake River spring-summer Chinook has averaged 0.9 percent SARs, achieving two percent in two of seventeen years. Snake River steelhead has averaged 1.6 percent SARs, achieving two percent in seven of thirteen years.

A greater amount of spill will improve in-river migration by increasing water velocities and reducing the amount time for out-migration by juvenile salmonids. Modeling has suggested that increasing spill levels to 125 percent will improve average SARs from 0.9 percent to 3.4 percent for Snake River spring-summer Chinook and from 1.6 percent to 4.1 percent for Snake River steelhead. The commenter described a ten year program for implementation of spill associated with the 125 percent modification.

The commenter states that allowing a modification of 125 percent will have minimal effects on salmonids and other aquatic life. The commenter asserts that the risk of gas bubble trauma posed to juvenile salmonids is less than the survival benefit of increased spill. Fifteen years of Smolt Monitoring Program data have indicated that total dissolved gas levels of 125 percent are associated with low incidence levels of GBT of approximately 2 percent. A literature review by the Fish Passage Advisory Committee found that considering depth compensation, in which the affects of TDG are reduced by 10 percent with every meter depth, aquatic animals at more than 2.5 meters depth are not be affected by 125 percent TDG. Additionally, aquatic animals residing

in shallow areas, near shore or off channel would be less exposed to high TDG because of limited mixing with high TDG flow and faster dissipation at higher surface area to volume ratios.

The commenter has acknowledged that a modification above 125 percent may require revision and U.S. Environmental Protection Agency approval of the Total Maximum Daily Load for Lower Columbia River Total Dissolved Gas.

The commenter requested the opportunity to give public comment during the Environmental Quality Commission meeting when the Commission is scheduled to decide on the approval of the modification.

DEQ Response to Initial Comments:
Regarding extending the time period the standard modification would be in continual affect, please see DEQ's response to commenter 1, above.

DEQ acknowledges that the Independent Scientific Advisory Board, in its "Review of the Proposed Spill Experiment," stated that considering the modifications made to the hydrosystem and the continuing inability of endangered salmon populations to meet smolt-to-adult return targets, increasing spill has merit as a hypothesis to test. However, the ISAB expressed concerns about the proposed experiment including the lack of a detailed study design and monitoring plan, which may cause the experiment to yield inadequate information. The ISAB also pointed to unintended consequences of months long exposure to 125 percent total dissolved gas by salmonids and other aquatic species. Within the context of experimental spill management, the ISAB's concerns would need to be addressed for DEQ to consider a request to increase the total dissolved gas modification to 125 percent.

DEQ must evaluate information supporting 125 percent, consider information from various stakeholders and seek input from other agencies to contribute to the scientific evaluation of 125 percent. The evaluation would consider potential effects on salmonids in addition to resident biological communities. Detailed physical and biological monitoring plans must also be submitted for review by DEQ.

DEQ considers total dissolved gas above the 120 percent standard modification as part of the margin of safety of the Total Maximum Daily Load for Lower Columbia River Total Dissolved Gas. As the commenter stated, DEQ believes a higher standard modification will likely require EPA approval of a revised TMDL.

There are no plans to have additional public comment on the TDG modification. However, a public forum is available during each EQC meeting.

Summary of Additional Comments from Oregon Department of Fish and Wildlife:
The commenter acknowledges DEQ's response to its initial comments and proposes working with DEQ to address issues associated with increasing the total dissolved gas modification to 125 percent. Regarding the availability of a total dissolved gas standard modification during March and September, the commenter proposes working with DEQ and the Corps to develop a standard

notification procedure and identify monitoring expectations to assist the Corps' ability to access the modification outside the April through August migration period.

DEQ Response to Additional Comments:
DEQ appreciates the commenter's offer to assist in issues associated with total dissolved gas in the lower Columbia River.

3. Pacific Northwest Generating Cooperative Power

The commenter supports the U.S. Army Corps of Engineers' request for the total dissolved gas standard modification. The commenter cautions that spills creating an excess of the 110 percent total dissolved gas water quality standard will pose a risk to migrating salmonids, which are to benefit from spill. Therefore, comprehensive TDG monitoring must accompany the Corps' spill program if the TDG standard modification is approved.

DEQ Response to Comments:
DEQ agrees that TDG monitoring is necessary to ensure salmonid protection. Physical and biological monitoring are requirements of the TDG standard modification approval. The U.S. Army Corps of Engineers provided DEQ with a Water Quality Plan which includes a description of the TDG monitoring network. The Fish Passage Center monitors juvenile salmonids for gas bubble trauma, resulting from exposure to supersaturated total dissolved gas, at Bonneville and McNary dams twice a week during the seasonal spill period from April through August. The Corps must also conduct physical and biological monitoring during any DEQ approved periods, outside of the juvenile migration period, for which the 120 percent modification will be in effect.

4. Northwest River Partners

Initial comments:
The commenter supports issuance the Corps' request for a modification to the total dissolved gas standard provided that monitoring is strictly enforced. The commenter states concern for the risk posed to aquatic biota when exposed to total dissolved gas above the 110 percent water quality standard. Although the commenter acknowledges the benefit of spill for migrating fish, they stress the importance of additionally utilizing transportation and cite study results in the 2014 Biological Opinion in which transportation returned a greater portion of adult Snake River steelhead and spring Chinook than the portion of adults that migrated in-river. The commenter also cautions that high levels of spill can increase the potential for adult fall back and reduce access to entrances of adult passage structures. The commenter provided graphical data from Columbia River Data Access in Real Time (DART) showing an increase in adult Chinook passage following the August 31, 2014, end of seasonal spill.

DEQ Response to Initial Comments:
DEQ acknowledges the importance of transport used in conjunction with in-river migration to spread the risk associated with recovery of Endangered Species Act listed salmonids. DEQ also acknowledges risks associated with high spill levels including adult fall back. Regarding risk to aquatic biota and monitoring, please see DEQ's response to commenter 3, above.

Summary of Additional Comments from Northwest River Partners:
The commenter reiterates support for issuance of the standard modification. However, the commenter cautions against too much spill and stressed protection of salmon and other species by not allowing a modification greater than 120 percent total dissolved gas during voluntary spill.

DEQ Response to Additional Comments:
DEQ appreciates the commenter's input.

5. U.S. Environmental Protection Agency

The commenter supports issuance of the draft order for the 120 percent total dissolved gas modification to benefit salmonids provided spill is mitigated as described in the draft order.

6. Bonneville Power Administration

The commenter supports DEQ's recommendation to grant the 120 percent TDG standard modification for seasonal fish passage from April through August, affective for the five-year period 2015-2019.

DEQ Response to Commenters 5 and 6:
DEQ appreciates the commenters' input.

Draft Order Approving the U.S. Army Corps of Engineers' Request for a Modification to the State's Total Dissolved Gas Water Quality Standard

BEFORE THE ENVIRONMENTAL QUALITY COMMISSION

In the matter of the U.S. Army Corps of Engineers' request to spill water to assist out-migrating threatened and endangered salmon smolts	))))	FINDINGS and ORDER

Findings

1. The Department of Environmental Quality received a request from the U.S. Army Corps of Engineers (Corps) dated April 2, 2014, to adjust the 110 percent total dissolved gas water quality standard as necessary to spill water over McNary, John Day, The Dalles and Bonneville dams on the Lower Columbia River to assist out-migrating threatened and endangered salmonid smolts during the fish passage season of Apr. 10 to Aug. 31. The application sought approval for five years. The public was notified of the request on Sep. 10, 2014, and given the opportunity to provide written comments until 5:00 p.m. on Oct. 10, 2014.

2. Acting under **OAR 340-041-0104(3)** the commission finds that:

   (a) *Failure to act would result in greater harm to salmonid stock survival through in-river migration than would occur by increased spill:*

   Biological assessments and opinions have concluded that providing project spill for fish passage at levels that result in exceeding the 110 percent total dissolved gas water quality standard is necessary to assure adequate passage conditions for Endangered Species Act listed fish species. Voluntary fish passage spill is a low risk method for fish to move downstream. Depending on the dam and species, spill passes approximately 55 to 80 percent of juvenile salmonids. Although structural and operational modifications have improved survival through turbines, spill has greater survival of approximately 95 percent compared to turbine passage at approximately 90 percent survival. The Independent Science Advisory Board and National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) continue to support transport in conjunction with spill to spread the risk of negative outcomes due the different types of passage. However, transportation is associated with greater likelihood of adult straying, in which adults do not return to spawn in their natal streams. Straying inhibits recovery of endangered and threatened salmonid species. The experience of in-river migration contributes to genetic adaptation of the species to altered conditions. The Biological Opinion incorporates hatcheries as a means of supplementing salmonid numbers until the species can sustain itself. The presence of in-stream migrating hatchery smolts reduces

the amount of wild smolts subject to predation and mitigates a portion of wild smolts lost to turbines or other causes during dam passage. However, hatchery fish can compete with wild fish for food and habitat and interfere with the wild fish's genetic adaptation to its environment.

(b) *The modified total dissolved gas criteria associated with the increased spill provides a reasonable balance of the risk of impairment due to elevated total dissolved gas to both resident biological communities and other migrating fish and to migrating adult and juvenile salmonids when compared to other options for in-river migration of salmon:*

Fish Passage Center data estimate a 1.1 percent incidence of gas bubble trauma in salmon smolts in the Columbia River when total dissolved gas levels are managed to 120 percent in the tailrace. This estimate is based on smolt monitoring information collected between 1995 and 2014.

When the in-river total dissolved gas levels are below 120 percent, few adult fish (in some cases none) display signs of gas bubble trauma. Investigators have observed adult tolerance to total dissolved gas and hypothesized that it was attributable to the migration depth of adult salmonids. Depth-sensitive radio tags used in adult migration studies confirmed that adults migrate at depths up to 4 meters and find depth compensation protection from gas bubble trauma. For every meter below the surface water, a reduction of 10 percent total dissolved gas is measured in the water column. Resident fish and aquatic invertebrates in the Columbia River downstream of Bonneville Dam have been monitored by NOAA Fisheries for signs of gas bubble disease from 1993 to 1998. There were no signs of gas bubble disease observed in the aquatic invertebrates examined. There was a low incidence of gas bubble disease (less than one percent) in resident fish examined in 1993 and 1995 while in 1994, 1997 and 1998 none of the fish observed had signs of gas bubble disease. Signs of gas bubble disease were prevalent in 1996 but this was a high flow year with large volumes of involuntary spill and total dissolved gas levels above 120 percent in the tail races of dams. Given the past monitoring of gas bubble disease, the level requested in this petition strikes a reasonable balance between increased survival due to reduced turbine mortality and the risk of mortality from gas bubble disease.

c) *Adequate data will exist to determine compliance with the standards:*

Physical in-river total dissolved gas monitoring will be conducted at the tailraces of McNary, John Day, The Dalles and Bonneville Dams. Hourly data will be available on the Corps' website. The Corps has submitted a total dissolved gas monitoring plan available at: http://www.nwd-wc.usace.army.mil/tmt/wqnew/tdg_monitoring/2015-18.pdf
Implementation of the physical monitoring plan will ensure that data will exist to determine compliance with the standards for the voluntary spill program identified in this Order. The Corps will report each year's physical monitoring results to DEQ.

d) *Biological monitoring is occurring to document that the migratory salmonid and resident biological communities are being protected:*

The Corps has submitted a biological monitoring plan. Biological monitoring will occur according to the Fish Passage Center 2009 document "GBT Monitoring Program Protocol for Juvenile Salmonids," available at: ftp://ftp.fpc.org/gbtprogram/ . Juvenile salmonids will be collected at Bonneville and McNary Dams and examined and evaluated for incidence of gas bubble trauma, and will be assigned ranks based on severity of their symptoms. The Corps will report each year's biological monitoring results to DEQ.

Order

1. The Environmental Quality Commission approves a modification to the 110 percent total dissolved gas water quality standard for voluntary fish passage spill at McNary, John Day, The Dalles and Bonneville Dams on the Lower Columbia River, subject to the following conditions:

   (i) The modified total dissolved gas standard for the Columbia River applies during the voluntary spill period from 00:00 Apr. 1 to 24:00 Aug. 31 for the purpose of fish passage.

   (ii) The DEQ Director may approve additional periods of modified total dissolved gas standard for the Columbia River for voluntary spill to benefit fish passage, including the Spring Creek Hatchery fish release, maintenance activities, and biological or physical studies of spillway structures and prototype fish passage devices. The Corps must notify DEQ in writing describing the purposed action, the purpose of the action and dates of action at least one week prior to the voluntary spill. The Corps must obtain approval from the Director prior to such spill.

   (iii) The modified total dissolved gas criteria will apply for five years, 2015, 2016, 2017, 2018 and 2019.

   (iv) The Corps must conduct physical and biological monitoring during all periods of voluntary spill. The monitoring must be adequate to implement the requirements set out in subsections (v) to (x) below.

   (v) Spill must be reduced when the average total dissolved gas concentration of the 12 highest hourly measurements per calendar day exceeds 120 percent of saturation in the tailraces of McNary, John Day, The Dalles and Bonneville Dams monitoring stations.

   (vi) Spill must be reduced when instantaneous total dissolved gas levels exceed 125 percent of saturation for any 2 hours during the 12 highest hourly measurements per calendar day in the tailraces of McNary, John Day, The Dalles and Bonneville Dams monitoring stations.

(vii) If either 15 percent of the fish examined show signs of gas bubble disease in their non-paired fins, or five percent of the fish examined show signs of gas bubble trauma in their non-paired fins where more than 25 percent of the surface area of the fin is occluded by gas bubbles, the DEQ Director will halt the spill program.

(viii) The Corps must provide written notice to DEQ within 24 hours of any violations of the conditions in the modification as it relates to voluntary spill. Such notice must include actions proposed to reduce total dissolved gas levels or the reason(s) for no action.

(ix) No later than Jan. 31 following each year of this modification, the Corps must provide an annual written report to DEQ detailing the following:

a) flow and runoff descriptions for the spill season;
b) spill quantities and durations;
c) quantities of water spilled for fish versus spill for other reasons for each project;
d) data results from the physical and biological monitoring programs, including incidences of gas bubble trauma;
e) description and results of any biological or physical studies of spillway structures and prototype fish passage devices to test spill at operational levels; and
f) progress on implementing the gas abatement measures contained in the 2002 Total Maximum Daily Load (TMDL) for Lower Columbia River Total Dissolved Gas and other gas abatement activities identified through adaptive management.

(x) If requested, the Corps must report to the commission on any of the above matters or other matters relevant to this order.

(xi) The commission reserves the right to terminate or modify this order at any time.

Adaptive Management

Implementation of the TMDL for Lower Columbia River Total Dissolved Gas will continue. Oregon and Washington may request further studies to determine additional structural and operational gas abatement actions that can be feasibly implemented to reduce total dissolved gas.

Dated: _____ ON BEHALF OF THE COMMISSION

_____
Director