CENWD-PDD 2 June 2008

MEMO FOR: Andrew Kolosseus (WDOE), AMT Co-chair
Agnes Lut (ODEQ), AMT Co-chair

FROM: Rudd Turner (Corps of Engineers), AMT member

SUBJECT: Corps comments on Resident Fish Literature Review by Mark Schneider.

As requested, this memo provides Corps of Engineers (Corps) comments on the draft report, "Resident Fish Literature Review", prepared by Mark Schneider for the AMT, dated May 12, 2008.

The report's information and conclusions on depth compensation relative to total dissolved gas (TDG) effects on fish describe a well established phenomenon. The spill risk assessment in the NMFS 2000 Biological Opinion (BiOp), as well as their most recent assessment which was included in the materials provided to the states in November 2006 for the states' current TDG waiver and criteria adjustment, conclude that TDG levels up to 120% do not pose a serious problem for actively migrating salmonids where compensating depths are available.

In our view, the key uncertainties in the toxicity discussions at AMT relate to chronic, sublethal toxicity effects to fish and other aquatic species, and ecological effects on shallow water habitats downstream of projects where water depths are insufficient for depth compensation to occur. The Schneider literature review provides little information on these effects, as there is not an extensive publication record on these effects.

However, recent detailed reviews of these topics are provided in a 2007 TDG literature review by WDOE (Maynard, C. September 2007. Evaluation of TDG Biological Effects Research.) and a 2006 report prepared by Battelle under contract to the Corps (McGrath, K.E., E.M. Dawley, and D.R. Geist. March 2006. Total Dissolved Gas Effects on Fishes of the Lower Columbia River. Report no. PNNL-15525. Prepared for the Corps' Portland District, contract # DE-AC05-76RL01830).

The WDOE report reviewed 154 studies and documents on TDG effects, concluding that numerous data gaps exist relative to long term exposure effects, depth distribution, duration of exposure & behavior, species specific tolerances, and life stage tolerances. The Battelle review cited 64 peer reviewed and agency published reports on TDG effects which the authors determined were relevant to habitats downstream of Bonneville Dam. The report raised concerns about sensitive or vulnerable life history stages of aquatic organisms, long term chronic or multiple exposure effects, vulnerable habitats and reaches, community & ecosystem effects, and incubation & rearing effects in shallow water areas. The report's conclusions were based on empirical evidence but also

recognized a lack of sufficient evidence to reach a scientific conclusion on the effects of TDG in the lower Columbia River.

The Maynard (2007) and McGrath et al. (2006) reviews include annotated bibliographies and provide relevant information on TDG toxicity issues before the AMT. A thorough resident fish literature review would include these reports. Further, these reports should be used by the states in making their recommendations on the need to maintain the 115% TDG forebay management limit for environmental protection.

The Schneider report gives some results of field studies but does not describe methods of examining organisms collected for those studies. Those methods should be described. Were all the field studies cited based solely on external examinations for gas bubbles, or were other methods used? Macroscopic, externally visible gas bubbles are associated with more advanced stages of gas bubble disease (GBD), and may indicate some mortality is already occurring in the population. This is more an indicator of acute, lethal toxicity effects than of sublethal, chronic effects. The limitations of this level of examination should be factored into the interpretation of field studies which rely on this metric.

The reviews of several reports also indicate that 120% TDG saturation exceeds the threshold level where acute toxicity effects are observed. According to the report, Ryan et al. (2000) showed 15% - 25% GBD when TDG levels were 120% - 130%, indicating significant toxicity effects at 120% (page 8). Toner et al. (1995) saw diminished GBD signs at less than 120%, which could also mean that 120% was associated with more consistent GBD signs (page 10). Mortalities in shallow water cages observed by Schrank et al. (1997 & 1998), while not reflecting effects if depth compensation is available, leaves open the important question of how shallow water habitats are utilized or impacted during periods of high TDG (page 11). The report states that Toner and Dawley (1995) reported external TDG signs of less than 10% in resident fish species. However, this could still be a significant impact since the report also states that TDG was under 120% most days. The cited results also show that levels below 120% are safer for fish, even when depth compensation is available.

Page 6, lines 1 & 2: The graph on page 6 shows an increase in GBT signs at 115%, not 120% as the text states. GBT signs increase more dramatically when tailwater gages are at or above 120% TDG. At these tailwater TDG levels, spill management at both the 115% forebay and 120% tailrace limits is probably being lost as well. The GBT data may show that 115% is a more reliable biological effects threshold than 120%.

Page 6, Figure 1: Text is missing from the caption below the figure and should be included.

Page 6, Figure 1: This is a very broad look at the biological data. All projects and years are combined, so it is not possible to tell what is happening at specific projects or during varying flow conditions such as high, average, and low water years. In addition, comparison of the biological data with the upstream tailwater TDG is not a very direct

analysis. These gages are about 25 - 30 miles upstream of where fish are sampled and evaluated for GBT. The tailwater gages measure gas levels before they drop off in the reservoir, and several days prior to sampling for GBT signs. The forebay gage at the project where the fish were sampled would provide a more direct reference point. This is much closer to the location and time of sampling, and is more representative of TDG levels the fish have been exposed to prior to sampling.

In the 2000 BiOp spill risk assessment (Appendix E), gas bubble signs were compared with TDG % saturation, averaged for the 12 highest hours in a day, in the forebay of the project where the sample occurred, and on the day the fish were examined (see Figures E-2 and E-3 for yearling Chinook and steelhead, respectively). This forebay comparison should be adopted for the current report as well. The 2000 BiOp graphs show a distinct increase in percent fish with signs starting at 116-120 % forebay TDG. In both cases, reliance on a single TDG gage as a point of reference ignores the cumulative effective of multiple reservoirs and spillways which has more to do with the observed GBD signs. So neither analytical method is perfect, but using forebay TDG data at least is based on a more direct relationship.

An additional limitation of the GBD information is the remoteness of sampled fish from the points of TDG loading, which primarily are spill discharges at upstream dams. We are not aware of any other CWA compliance monitoring protocols that allow sampling this far away from points of contaminant loading into water bodies.

While the information in Figure 1 is very general, it does show that external biological effects increase noticeably at tailwater TDG levels of 115 - 119%, and they increase substantially when forebay TDG is likely exceeding 115% as well. That is what would be occurring when TDG at the tailrace gage of the next project upstream is exceeding 120%. If anything, the data shown reinforce the overall importance of keeping the 115% forebay gages in place.

Note: Schneider's Figure 1 appears to show the same data set as the figure in the Fish Passage Center's biological monitoring presentation, which also was provided at the May 13, 2008 AMT meeting. The one difference is the scale of the Y axes. Therefore, comments on this report's Figure 1 apply to the FPC figure as well.

Page 9, paragraph 2, line 2: "Fish were held in shallow 0.25cm deep tanks…" This is very shallow indeed, about 1/8 inch. Should the unit be meter (m), perhaps?

Page 12, Conclusions, bullet 1: This report does not discuss the physical TDG monitoring program. The bullet 1 conclusion should be deleted.

Page 12, Conclusions, bullet 2: This report does not address specifically the validity of risk analysis in the biological monitoring program. The bullet 2 conclusion should be deleted.

Page 12, Conclusions, bullet 3: The report cites a range of TDG levels where biological effects are first observed in different studies. A specific level such as 123% cannot be derived from the literature cited. The bullet 3 conclusion should be modified to reflect this uncertainty.

Page 12, Conclusions, bullet 5: Some of the cited literature shows adverse effects at TDG levels less than 120% of saturation. The bullet 5 conclusion is inconsistent with the results cited in the report. It should be modified also.

Finally, while not a purpose of this review, it should be noted that a comparison of TDG toxicity effects with and without the 115% TDG forebay management limit in place is not provided in this report, nor is it included in any of the other toxicity information put before the AMT. This makes it difficult to draw definitive conclusions about the question before the AMT.