Date: October 5, 2017

Written testimony of Margaret Tauzer, hydrologist, National Marine Fisheries Service

1. I am a hydrologist for the National Fisheries Service (NMFS). I have a Master of Science degree in Civil Engineering, with an emphasis in Water Resources and River Mechanics from Colorado State University and a Bachelor of Science degree in Environmental Resource Engineering from Humboldt State University. I have been employed as a hydrologist for NMFS for over 17 years. While at NMFS, I have provided hydrologic-based effects analysis to minimize effects for section 7 consultations for many project types. Some of the major projects I have been involved in are: fish passage crossings, stream flow based gravel extraction methods and extraction limits. I have reviewed, analyzed and submitted multiple water right protests to notices to appropriate water to the State Water Resources Control Board. I have served on many technical advisory committees to evaluate bypass flow recommendations. Examples are 1) Mattole Headwaters Steamflow Improvement plan, 2) Sproul Creek Instream Flow study, 3) the Draft Guidelines for Maintaining Instream Flows in Mid-California Coastal streams, 4) Trinity River Restoration Project, and 5) Humboldt Bay Municipal Water District 1707 stream flow dedication. Prior to employment with NMFS, I had over 9 years of experience employed as an engineer for private consulting firms (Hydrocomp, Inc. and Hydro Research Science) working on mathematical and physical river and watershed models (see resume **exhibit 2**). My written testimony incorporates by reference information in all exhibits referred to in this document.

2. In 2001, NMFS and CDFW both submitted water rights protests to the Marble Mountain Ranch's application for an appropriate water right on Stanshaw Creek. NMFS' recommendation, based on a 3.0 cubic feet per second (cfs) maximum diversion, was to provide a 50% bypass flow at the point of diversion (POD), with no diversion when the stream flow drops below 1.5 cfs, and that the non-consumptive diversion used for hydroelectric generation be returned to Stanshaw Creek above Highway 96. The diversion continued unresolved for years following the recommendation.

3. On August 3, 2016, NMFS submitted a letter to SWRCB with recommended bypass flow to protect coho salmon and their habitat as a Public Trust Resource (**exhibit 3**). The Marble Mountain ranch diversion evaluated in our analysis is for the claimed pre-1914 water right of 0.31 cfs (200,300 gallons per day) for consumptive use and 2.69 cfs (1,731,500 gallons per day) during hydro-electric operation. As the letter explains, our recommendation is to maintain a minimum bypass of at least 90% of the unimpaired flow throughout the year within the anadromous reach of Stanshaw Creek. (Based on a habitat survey by Ross Taylor, coho salmon are not likely to pass the natural boulder cascade just upstream of the Highway 96 culvert which is generally assumed to be the limit of

anadromy). Our recommendation allowed the requested maximum diversion of 3.0 cfs at the POD as long as a minimum of 2 cfs is bypassed in the non-anadromous reach below the point of diversion POD and the non-consumptive diversion is returned to Stanshaw Creek above the anadromous reach. The recommendation allows for a 10% consumptive use diversion from Stanshaw Creek at the POD throughout the year when unimpaired flows drop below 2 cfs. The letter explains why we believe a bypass flow of 90% of the unimpaired flow provides protection of water quality in the off-channel pond at the confluence with the Klamath River and cold water salmonid refugia in the Klamath River. The letter also explains how we used hydraulic analysis of the non-anadromous reach to determine that a 2 cfs minimum bypass will maintain the wetted low flow channel needed to maintain macroinvertebrate production and food transport throughout the non-anadromous reach below the POD. **Exhibit 6** shows photos taken on the date of NMFS topographic survey above the anadromous reach in Stanshaw Creek on July 1, 2001. The streamflow of 2.7 cfs was measured above the POD on the same day.

4. Since our initial evaluation in 2001, there have been additional studies focused on the value of off-channel and cold water refugia supplied at tributary confluences on the Klamath River to salmonids, including state and federally-listed coho salmon (Asarian 2013, Witmore 2014, Bartholow 2005, Holtby, Anderson and Kadowaki 1990). A full list of references is shown in **Exhibit 42**. Therefore, we re-evaluated the hydrologic conditions of Stanshaw Creek and original hydraulic analysis of the reaches below the POD. As NMFS explained in the August 3, 2016 letter (exhibit 3), based on the hydraulic analysis and the habitat values of the reach, we conclude that habitat conditions sufficient for proper functioning of the riverine ecosystem, including relevant coho salmon life stages, could be met as long as at least a minimum of 2 cfs remain in the non-anadromous reach. Additionally, at least 90% of the natural flow should remain in the lower anadromous reach with the return of the hydroelectric diversion or at least 90% of unimpaired flow is bypassed at the POD when unimpaired flows drop below 2 cfs naturally. Our initial 2015 bypass recommendation, **exhibit 5**, recommended a forbearance period between May 15 and October 31 for non-consumptive diversion. We later adjusted this initial recommendation to those described in our August 3, 2016 letter based on landowner input received by email (**exhibit 11**). Our final bypass flow recommendation had no date driven forbearance period, using only hydrologic indicators to limit the diversion (eg. On wet years hydroelectric operation could occur longer into the low flow season than on dry years as long as the minimum 2 cfs is met in the non-anadromous reach of Stanshaw Creek downstream of the POD). The maintenance of the 90% natural flow could be met by return flow from the hydroelectric generation as long as water temperature of the natural channel is maintained.

5. A summary of the timeline of NMFS correspondence with recommendations is shown in the following table:

Table 1 Correspondence timeline

Date	correspondence	Maximum diversion (consumptive plus non-consumptive)	Minimum bypass in anadromous reach	Minimum bypass at POD	Return hydroelectric to Stanshaw Creek	Dates of no non-consumptive diversion
November 15, 2001	NMFS protest letter with terms to remove protest application #29449	3.0 cfs	50% bypass at POD.	50% and with minimum bypass of 1.5 cfs, below which no diversion	Above highway 96	No date restrictions
July 1, 2015	NMFS bypass flow recommendation to protect Public Trust Resources, email with attachment sent to SWRCB	3.0 cfs	90% of natural flow or 2 cfs plus hydroelectric return.	2 cfs min. bypass non-anadromous reach Nov 1-May 14. 90% bypass and 1.5 cfs minimum bypass (i.e. no diversion if Q<1.5)	Above highway 96	10% unimpaired flow diversion between May 15 and Oct 31
August 3, 2016	NMFS Letter with final recommendations to protect public trust resources	3.0 cfs	90% of natural flow	2 cfs, or 90% of natural flow when no hydro-electric diversion	Above anadromous reach	No date limit

6. On August 5, 2016, NMFS sent a correction to the example used in the August 3, 2016 letter to the stakeholder group. The email explained that the change did not affect the NMFS bypass flow recommendation, but only slightly affected the diversion timing in the example. The corrected figure showing the bypass flows and diversions at the POD and within the anadromous reach is shown in Figure 1. The figure is from the spreadsheet of **Exhibit 4 on the tab labeled "1.StanshawcreekNodates"**.

7. **Exhibit 4** is the Excel spreadsheet used to evaluate the bypass flow recommendation by utilizing estimated, realistic hydrographs of unimpaired flow in Stanshaw Creek based on the nearby Ti Creek gaged streamflow data. The spreadsheet shows the estimated streamflow data, calculations and figures used to evaluate the recommendation. The spreadsheet shows an example of how the recommendation would affect the hydrograph and the rate and amount of time the consumptive and hydroelectric diversion are met. Our August 3, 2016 letter (Exhibit 3) explains how we used the Ti Creek data to estimate the daily average flow rate on Stanshaw Creek. The letter also explains how we analyzed other nearby gages to show the Ti Creek data used was representative of a wide range of water year types.

8. The Excel spreadsheet (Exhibit 4) has nine tabs. The content of each tab is explained in the following table:

Table 2 Excel Spreadsheet tab description

TAB	Tab Name	
1	StanshawcreekNodates	Main sheet to estimate daily diversions and bypass flows, user input window included
2	ChartNoDates	Chart showing bypass flows, the chart automatically incorporates changes based on user input and values calculated in TAB 1.
3	Chart1963	Chart showing bypass and diversion estimated values for 1963 between April and December based on values calculated in TAB 1.
4	bypassflowchart	Chart showing bypass flows at POD, in anadromous reach, and in non-anadromous reach based on values calculated in TAB 1.
5	Stanshawflows update	Tab showing estimates of daily average flow in Stanshaw Creek, also Pivot tables showing minimum values of 7-day averages for period of daily average flow estimates.
6	TiCreekChart	Chart showing period of record of Ti Creek flow records.
7	hydropowerdays	Pivot tables and chart showing estimated days of hydroelectric operation based on assumed minimum value for hydroelectric operation. Chart changes with user input on TAB 1.
8	StanshawCreekDates	Obsolete bypass and diversion estimates based on previous recommendations with forbearance period.
9	ChartStanCrkDates	Obsolete chart of bypass and diversion estimates based on values from TAB 8.

Tab 1 of the spreadsheet was built to evaluate the recommendation and to use for demonstration to the stakeholder group. Within Tab 1 are some highlighted cells that accept user input to help visualize the changes in bypass flow and diversions. Variables that can be adjusted are: 1) maximum diversion rate, 2) minimum hydroelectric diversion, 3) consumptive use, 4) maximum percent of flow for diversion at POD, 5) minimum bypass at POD, and 6) with or without hydroelectric return flow. Tab 1 allows a daily estimate of bypass flows in both the non-anadromous reach and the anadromous reach following our final recommendations. In addition, rate of diversion for consumptive and hydroelectric use are calculated on a daily basis in tab 1. The values are calculated by subtracting the diversions from the unimpaired flow estimates within the constraints required by our bypass flow recommendations. The constraints are maximum allowed rate of diversion, the minimum bypass flows, and the lower limit of hydroelectric operation. The values in some of the cells within the spreadsheet are calculated from equations that use the values from other cells within the spreadsheet. Many of the calculated cells use logical equations to find the appropriate value for the cell that fit all constraints. An example of how the spreadsheet works can be seen in the equation from cell J42 of Tab 1. This cell is used to estimate the bypass flow that would occur at the POD under the constraints defined in the user input window (highlighted in yellow on the sheet). The equation within cell J42 is =IF((1-$K$31)*G42<$K$33,(1-$K$31)*G42,IF(G42>$K$32+$K$33,(G42-$K$32),$K$33)). This equation is known as a logical statement in computer language and is used to determine the bypass flow at the POD for the day. The value for the cell is calculated by first checking if 90% of the unimpaired flow is less than the minimum bypass flow at the POD for non-consumptive use (i.e. IF (1-$K$31) x G42<$K$33), then the bypass at the POD will be 90% of the unimpaired flow ((1-$K$31)*G42). If the last condition is not met, the equation checks whether the unimpaired flow is higher than the minimum bypass flow plus the maximum diversion amount (i.e. G42>$K$32+$K$33), in which case the bypass flow would be the streamflow minus the maximum diversion amount (i.e. G42-$K$32), if neither of those scenarios is true then the minimum bypass must be the minimum bypass for non-consumptive use (i.e. = $K$33 = 2 cfs).

Tabs 2, 3, and 4 are charts of the estimates from Tab 1. These charts are interactive and change with the input of Tab 1.

Tab 5 shows calculations of daily average flows for Stanshaw Creek based on scaling the gaged Ti Creek data by ratio of watershed area (column F). Also on tab 5 are excel Pivot Tables that summarize and find the minimum, maximum, and average 7-day-average flow by month using daily 7-day average values calculated in column G.

Tab 6 is a chart of Ti Creek daily average flows at the USGS Ti Creek streamflow gage for the period of record.

Tab 7 uses Excel Pivot Tables to summarize the data from Tab 1 by year. The Tab 7 also has a figure showing estimated number of days of hydro power use per year with the user input values and bypass flows on Tab 1.

Tab 8 and tab 9 are obsolete and abandoned worksheets used for the original 2015 recommendation that included forbearance dates as explained above.

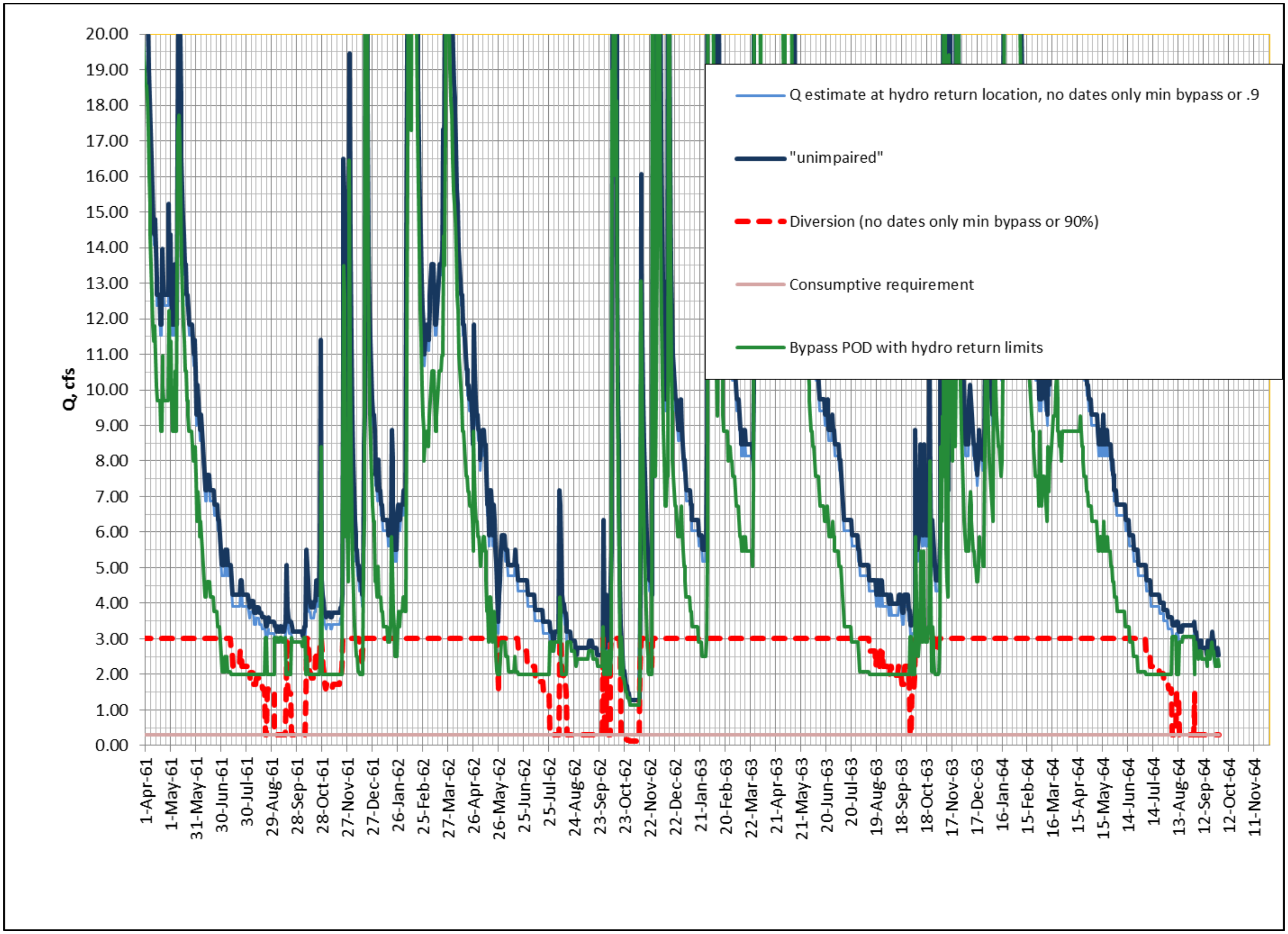

Figure 1 Corrected figure showing example of recommended bypass flows on Stanshaw Creek with a maximum diversion of 3.0 cfs.

9. Since 2001, the applicant has manipulated the stream with a gavel/cobble dam to divert water down a ditch toward the hydroelectric unit and toward the Marble Mountain Ranch. From our observations, the method of diversion causes large alterations and sediment input to the stream and is not an efficient method of diversion. The leakage at the diversion dam and in the ditch results in limited or no hydroelectric operation in the low flow months. We think our recommendation provides at least the same amount of hydroelectric operation while minimizing effects downstream.

10. Exhibit 3 NMFS letter to SWRCB explains how the years used in the example are representative of a broad range of water year types. Based on these example years, our evaluation shows that the hydroelectric operation could be achieved from 300 to 336 days per year (assuming a minimum flow of 1.1 cfs required for hydroelectric operation). If the minimum flow to operate the hydropower is 2 cfs (see Will Harling email response **exhibit 12**), we estimate there would no significant change to the non-consumptive hydroelectric diversion with our recommendation compared to a hydroelectric diversion with a 50% bypass requirement. In other words, our bypass recommendation allows a large diversion (up to 53% of the unimpaired flow) as long as the flow is returned before the anadromous reach and the 2 cfs is maintained in upper reach. We also think that a more efficient diversion and piped arrangement will lead to a more reliable system providing at least as much water as the current supply. Figure 1 and figures in Exhibit 4 show the bypass in the upper reach.

    We have calculated and made our bypass flow recommendations that we consider to have a low level of impact to ESA-listed coho salmon and their critical habitat. We did not consider how the diversion may be divided between multiple users. The highest level of protection for coho salmon and their habitat, while still allowing a diversion, would be for all users to share the amount of water available under these recommendations. The consumptive use evaluated is 200,344 gallons per day and the non-consumptive use is near 2,000,000 gallons per day. We recommend that the timing of use be considered. Our recommendation, to minimize effects to coho salmon and their habitat, is to establish the minimum level rate of diversion needed to meet the daily volume requirements. The minimum rate of diversion would likely require additional storage so that a low rate of diversion, constant over 24-hours, can be stored to meet the higher day-time water demand.

References:

Asarian, E. K., Jacob PhD. 2013. Synthesis of Continuous Water Quality Dat for the Lower and Middle Klamath River, 2001-2011. 50. Klamath Basin Tribal Water Quality Group.

Bartholow, J. M. (2005) Recent water temperature trends in the lower Klamath River, California. *North American Journal of Fisheries Management,* 25**,** 152-162.

Holtby, L. B., B. C. Anderson & R. Kadowaki (1990) Importance of Smolt Size and Early Ocean Growth to Interannual Variability in Marine Survival of Coho Salmon (Onchorhynchus kisutch). *Canadian Journal of Fish Aquatic Science***,** 14.

Witmore, S. K. 2014. SEASONAL GROWTH, RETENTION, AND MOVEMENT OF JUVENILE COHO SALMON IN NATURAL AND CONSTRUCTED HABITATS OF THE MID-KLAMATH RIVER. In *Natural Resources*, 75. Humboldt State University.