MEMORANDUM

To:	Jim Kramer	**Date:**	December 17, 2012
From:	Bob Montgomery	**Project:**	120404-01.01
Re:	Chehalis Fisheries Studies		

Anchor QEA has performed two fisheries studies under contract with the Chehalis Basin Flood Authority. The first study Anchor QEA completed for the Flood Authority was an analysis of the effect of the flood retention structure alternatives (multi-purpose dam with optimized flow regime, flood storage only dam) on spring Chinook salmon, steelhead and coho salmon in WRIA 23 (the upper Chehalis Basin). That study is titled "Chehalis River Flood Storage Dam Fish Population Impact Study" (Fish Study) (Anchor QEA, 2012a). The second study, titled "Draft Chehalis River Basin Comprehensive Salmonid Habitat Enhancement Plan" (Enhancement Plan) (Anchor QEA, 2012b) developed a prioritized list of potential opportunities to improve fish habitat conditions in WRIA 23. An approach to estimating fisheries benefits for the enhancement projects was also provided in the Enhancement Plan. Both of these studies were funded by the State of Washington and were performed with extensive interaction with members of the Flood Authority.

This memorandum summarizes the results of the two studies and answers questions about the percentage of fish that originate from the Chehalis River basin upstream of the proposed flood retention structure (located at River Mile 108), the effect on those fish populations from the proposed structure, the relative effect compared to WRIA 23 and to the entire Chehalis River basin and the effect of habitat enhancement projects that were proposed in the Enhancement Plan both with and without the flood retention structure. The information presented in this memo is compiled from data collected for the Fish Study, from analyses performed for the Fish Study and the Enhancement Plan as well as calculations performed for the purposes of this memorandum. Additional detail and copies of calculations can be provided if needed.

Escapement above Location of Proposed Flood Retention Structure

Escapement counts (portion of fish population that reaches salmon spawning grounds) in WRIA 23 (upper Chehalis River basin) were obtained from Washington Department of Fish and Wildlife (WDFW). Table 1 provides a range of escapements and the calculated median.

Table 1
Escapement – WRIA 23

Specie	High	Low	Median
Spring Chinook	5,034	651	1,873
Steelhead	4,960	1,823	3,512
Coho	44,547	9,650	21,536

Note: Escapement is the portion of fish population that reaches salmon spawning grounds. Data obtained from WDFW, ten year median (1998 to 2007) for coho salmon and steelhead is shown while twenty year median (1991 to 2010) for Chinook salmon is provided.

The available data also separated the escapement from the mainstem Chehalis River within WRIA 23, which is shown in Table 2.

Table 2
Escapement – Mainstem Chehalis River within WRIA 23

Specie	High	Low	Median
Spring Chinook	1,388	107	358
Steelhead	1,736	434	1,289
Coho	1,936	38	607

Note: Escapement is the portion of fish population that reaches salmon spawning grounds. Data obtained from WDFW, ten year median for coho salmon and steelhead is shown while twenty year median for Chinook salmon is provided.

Escapement data is also available for the Chehalis River above the site of the proposed flood retention structure. Table 3 provides escapement counts above the site of the proposed structure and comparisons to escapement in the mainstem Chehalis River and WRIA 23. It shows spring Chinook and coho escapement above the site of the proposed structure are very small proportions (1-2%) of total WRIA 23 escapements for those species. Steelhead are a

much greater proportion; 29% of escapement in WRIA 23 is estimated to return upstream of the proposed flood retention structure.

Table 3
Median estimates of escapement above dam (RM 108 upstream),
mainstem Chehalis River, and all of WRIA 23

Species	Escapement above proposed dam	Escapement mainstem Chehalis River	Escapement all of WRIA 23	Percent of WRIA 23 escapement upstream of proposed dam
Spring Chinook	5	358	1,873	1%
Steelhead	1,034	1,289	3,512	29%
Coho	426	607	21,536	2%

Note: Escapement is the portion of fish population that reaches salmon spawning grounds. Data obtained from WDFW, ten year median for coho salmon and steelhead is shown while twenty year median for Chinook salmon is provided as additional data for Chinook is available.

Escapement counts in the entire Chehalis River basin (WRIAs 22 and 23) were also obtained from WDFW. Table 4 provides a range of escapements and the calculated median.

Table 4
Median estimates of escapement in WRIAs 22 and 23

Specie	High	Low	Median
Spring Chinook	5,034	651	1,873
Steelhead	15,825	5,964	10,110
Coho	87,776	15,993	31,768

Note: Escapement is the portion of fish population that reaches salmon spawning grounds. Data obtained from WDFW, ten year median (1998 to 2007) for coho salmon and steelhead is shown while twenty year median (1991 to 2010) for Chinook salmon is provided.

The proportions of steelhead and coho escapement above the site of the proposed structure compared to the entire Chehalis River basin (WRIA 22 and 23) are much smaller than shown in Table 3 for just WRIA 23. For steelhead, the proportion of median escapement is 10% and for coho is 1%. There is no change in median escapement for spring Chinook as there is only a very small population in WRIA 22.

The Shiraz fish population model was developed to estimate the impact of different dam alternatives on fish populations. The Shiraz model was developed for only mainstem fish populations in WRIA 23. The first step in the modeling process was to develop an existing conditions model. Table 5 provides output from the existing conditions model runs. The numbers are consistent with the measured escapement by WDFW. The percentage of escapement above the site of the proposed dam compared to the entire WRIA 23 ranges from 1% for Spring Chinook to 20% for steelhead. A complete description of the modeling process is not provided in this memo but is contained in the Fish Study.

Table 5
Percent of Median Escapement Upstream of Proposed Structure
Using Shiraz Model under Existing Conditions

Specie	Escapement above proposed dam	Escapement mainstem Chehalis River	Escapement, entire WRIA 23	Percentage escapement upstream of proposed structure to mainstem Chehalis River	Percentage escapement upstream of proposed structure to entire WRIA 23
Spring Chinook	19	320	1,835	6%	1%
Steelhead	571	628	2,851	91%	20%
Coho	615	676	21,113	91%	3%

Note: Escapement is the portion of fish population that reaches salmon spawning grounds.

Estimates of the Effects of the Flood Retention Alternatives on Fish Populations

The Fish Study presented estimates of the effect of the flood retention alternatives (multi-purpose dam with optimized flow regime, flood storage only dam) on spring Chinook salmon, steelhead and coho salmon. Those estimates are summarized in Tables 6 and 7.

Table 6
Estimates of Effects on Fish Populations with Multi-purpose Dam
and Optimized Flow Regime

Specie	Escapement above Dam	Escapement mainstem Chehalis River	Escapement, entire WRIA 23	Change from Existing Conditions Escapement	Percentage Change in Population compared to entire WRIA 23
Spring Chinook	46	769	2,284	449	20%
Steelhead	387	425	2,648	-203	-7%
Coho	441	485	20,922	-191	-1%

Notes: Escapement is the portion of fish population that reaches salmon spawning grounds. Results are from Shiraz modeling for a 50-year simulation period using target fish passage conditions and optimized flow regime. Medians are reported. Percentage change calculated by dividing change in escapement by total escapement in WRIA 23 under existing conditions.

Table 7
Estimates of Effects on Fish Populations with Flood Control Only Dam

Specie	Escapement above Dam	Escapement mainstem Chehalis River	Escapement, entire WRIA 23	Change from Existing Conditions Escapement	Percentage Change in Population compared to entire WRIA 23
Spring Chinook	15	249	1,764	-71	-4%
Steelhead	323	355	2,578	-273	-11%
Coho	351	386	20,823	-290	-1%

Notes: Escapement is the portion of fish population that reaches salmon spawning grounds. Results are from Shiraz modeling for a 50-year simulation period using target fish passage conditions. Medians are reported. Percentage change calculated by dividing change in escapement by total escapement in WRIA 23 under existing conditions.

Estimates of Effects from Habitat Enhancement Projects

The Enhancement Plan adopted the "Delphi" method of estimating benefits associated with a plan of extensive habitat enhancement measures in WRIA 23. Those measures include 300 fish passage projects, 48 floodplain reconnection and riparian enhancement projects, 2,115 acres of riparian restoration, and the addition of 3,696 pieces of large woody debris. The Delphi method uses local, expert opinion as the basis for estimating fish survival benefits

associated with proposed habitat enhancement actions. The Federal Columbia River Power System 2008 Biological Opinion Remand Habitat Workgroup developed the Delphi method. It has been widely used to provide qualitative estimates of potential benefits associated with habitat restoration actions in the Columbia River basin. Results from use of the Delphi method report the relative change in habitat quality and egg-to-smolt survival. An estimate of the number of additional returning adult salmon was then prepared using a range of ocean survival. This method was used instead of the Shiraz fish population model as the Shiraz model was prepared for the mainstem Chehalis River in WRIA 23 only and improvements in tributary fisheries from enhancement measures are not represented in the model.

The Enhancement Plan predicts an improvement in habitat quality and salmonid egg-to-smolt survival by 14, 44, or 73 percent under low, medium, and high restoration scenarios, respectively. Those improvements are compared to existing conditions, without either flood retention structure.

Data on coho salmon smolt production was provided by WDFW for WRIA 23 for the period from 1997 to 2007. Data on spring Chinook salmon and steelhead smolt production is not available. Therefore, we estimated the potential effects of the Enhancement Plan on coho salmon smolts only. The estimate is for coho salmon smolts originating in WRIA 23 and does not include WRIA 22.

To estimate the number of adult coho salmon that might be produced in the future if the habitat enhancement measures evaluated in the Enhancement Study were implemented, we multiplied smolt production (minimum and maximum in the last 10 years) by the estimated increase in egg-to-smolt survival (14, 44, and 73 percent increase in habitat quality and smolts) from enhancement measures. We then multiplied the increased number of smolts leaving the river under improved habitat conditions by the range in ocean survival (0.5 and 5 percent) they might encounter during ocean residency to estimate the number of returning adults. The results bracketed the potential response in adult escapement to habitat enhancement measures.

The additional number of adult coho salmon that could be produced from WRIA 23 if the habitat enhancement measures are implemented could vary greatly. Tables 8 and 9 provide a

range of potential increase in adult coho salmon escapement under varying enhancement levels and ocean survival. Assuming low ocean survival (0.5 percent), the range is 389 to 12,370 adult coho salmon (Table 8). Assuming high ocean survival (5 percent), the range is 3,890 to 123,700 adult coho salmon (Table 9).

Table 8
Estimates of Increase in Adult Coho Salmon Escapement in WRIA 23 with Low Ocean Survival

	Enhancement Level		
Smolt production	**Low**	**Middle**	**High**
Low	389	1,222	2,027
Median	1,388	4,363	7,238
High	2,372	7,456	12,370

Notes: Increase in adult coho escapement with low ocean survival (0.5 percent) and varying levels of enhancement (low, middle, and high) and smolt production (10 year low, median, and high).

Table 9
Estimates of Increase in Adult Coho Salmon Escapement in WRIA 23 with High Ocean Survival

	Enhancement Level		
Smolt production	**Low**	**Middle**	**High**
Low	3,890	12,223	20,278
Median	13,880	43,622	72,374
High	23,724	74,561	123,704

Notes: Increase in adult coho escapement with high ocean survival (5 percent) and varying levels of enhancement (low, middle, and high) and smolt production (10 year low, median, and high).

The estimated coho salmon adult escapement for WRIA 23 under existing conditions (shown in Table 1) range from 9,650 to 44,547 fish. The relative increase in population is 4% to 5% under the conservative assumptions of low enhancement levels and low ocean survival. That increase exceeds the estimates of impact to WRIA 23 coho populations from either dam alternative (1% decrease). With higher enhancement levels or higher ocean survival, the increase in returning adults would be much higher and would greatly exceed the potential impact to WRIA 23 coho populations from either dam alternative. For example using the middle enhancement level combined with low ocean survival results in a 20% increase in coho salmon population in WRIA 23. Additional development of the enhancement projects to determine their configuration and use by salmon would provide more information on the

potential benefits to coho populations and could provide a more firm estimate of potential increases in coho salmon adult returns.

The potential effects of the Enhancement Plan on spring Chinook salmon and steelhead in WRIA 23 was not estimated, but would likely be in the same range of improvement as described above for coho salmon for the following reasons:

- The mainstem Chehalis River floodplain habitat enhancement projects will enhance and increase the amount of winter and summer rearing habitat and habitat available to smolts during their downstream migration in the mainstem Chehalis River, Newaukum, Skokomish, Boisfort, and Lincoln management units (MU). Chinook salmon, steelhead and coho salmon are known to use the floodplain habitats proposed for enhancement including off channel ponds, side channels, wetlands, and beaver ponds (Solazzi et al. 2000; Henning et al. 2007).
- Steelhead and coho salmon spawn in many of the streams where fish passage improvement projects have been proposed (LCCD 2009; MCCD 2010; WDFW 2011).

The combination of the enhancement projects and the multi-purpose dam with optimized flow regime would greatly improve habitat conditions along the mainstem Chehalis River and in tributaries except upstream of the dam site. We were not able to estimate the potential benefits from that combination. However the increase in spring Chinook salmon would exceed the increases predicted in the Fish Study for the multi-purpose dam (20% increase relative to WRIA 23). Coho salmon would increase more than shown in Table 8 but would be offset slightly by a reduction in mainstem populations affected by the dam. Steelhead populations downstream of the dam site could also increase in a similar manner as predicted for coho salmon but may be offset by a reduction in population above the dam site.

Summary

The potential effect on spring Chinook salmon, steelhead and coho salmon in WRIA 23 were estimated using the Shiraz model for different dam alternatives. The effect of the multi-purpose dam with optimized flow regime and target fish passage conditions was an increase of 20% in spring Chinook salmon and a decrease in steelhead of 7% and coho salmon 1%. Those percentages are relative to total WRIA 23 escapements. The effect of the flood control

only dam alternative with target fish passage conditions was a decrease of 4% in spring Chinook salmon, steelhead of 11% and coho salmon 1%. Those percentages are also relative to total WRIA 23 escapements.

The effect of the enhancement measures proposed in the Enhancement Plan was estimated using the Delphi method. The potential benefits were estimated to be a 4-5% increase in coho salmon adults using conservative estimates of enhancement benefits and low ocean survival. The benefit may be much greater, as the estimated increase in coho salmon adults for a middle level of enhancement and low ocean survival was 20%. Either estimate would more than offset the impacts from the reservoir alternatives. Smolt data for Chinook salmon and steelhead were not available to use the Delphi method, but our opinion is the increase in those populations would likely be in the same range as described for coho salmon. The enhancement measures would improve spring Chinook populations and would likely offset impacts from the flood control only alternative. The multi-purpose alternative was predicted to result in a significant increase in spring Chinook populations (increase of 20%) using the Shiraz model and any enhancement measures would further benefit those populations. The Shiraz model predicted a decrease of 7% in steelhead populations with the multi-purpose dam alternative. The enhancement measures would improve steelhead populations however it is not known at this time if they would fully offset the 7% decrease. Further data collection on steelhead smolt outmigration, adult use of the Chehalis River, additional development of enhancement opportunities to address steelhead limiting factors and extension of the Shiraz model to the entire WRIA 23 to model all steelhead populations would help answer that question.

The proportion of spring Chinook, steelhead and coho escapement above the site of the proposed flood retention structure compared to the entire Chehalis River basin (WRIA 22 and 23) was also calculated. For steelhead, the proportion of median escapement above the structure compared to the entire Chehalis River basin is 10% and for coho is 1%. There is no change in proportion of median escapement for spring Chinook (less than 1%) as there is only a very small population in WRIA 22. Relative to the entire Chehalis River basin, the impacts to populations from the flood retention structure would be less and the benefits from the enhancement measures would also be less.

References

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