Final Report

Tributary Streamflow Technical Committee

October 2, 2006

Regional Water Supply Planning Process

Table of Contents

Appendices

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Purpose

Multiple agencies, the Muckleshoot Indian Tribe, utilities, and organizations are voluntarily participating in a regional water supply planning process for the purpose of compiling data and discussing issues relating to water supply and streamflows for salmonid survival. The goal of the planning process is to compile the best available information and to develop pragmatic tools that participants may use, at their discretion, to assist in the management of their water systems and in their water supply planning activities. To that end, the Tributary Streamflow Technical Committee worked to create a prioritized list of candidate streams for the purpose of future flow restoration using source exchange (defined below). The geographic scope of the Committee's work was purposely limited[1] to the Water Resource Inventory Areas (WRIAs) 8 and 9, the Cedar-Sammamish-Lake Washington and Green-Duwamish watersheds, respectively.

Source exchange can be defined as the temporary or permanent replacement of existing sources of water supply with water supply from sources that have less or no impact on instream flows, particularly during critical periods for salmon or steelhead. The objective of source exchange is to use new or different sources of water in a manner that will provide the greatest biological benefits to salmon and steelhead populations. As part of the regional water supply planning process, utilities and organizations working in the Source Exchange Committee will explore the feasibility of source exchange projects including implementing a potential pilot project(s). In addition, the Reclaimed Water Technical Committee is recommending a framework to evaluate source exchange opportunities that use reclaimed water, thereby benefiting instream flows. To advance this work, the Tributary Streamflow Technical Committee developed a scope of work to investigate streamflow responses of resting or pausing wells on a seasonal basis (Appendix E).

The Tributary Streamflow Technical Committee ranked a limited number of streams in WRIAs 8 and 9 to establish *relative* priorities for potential stream flow restoration using source exchange. Many streams in these two watersheds were not ranked by the Committee because they were not previously identified in the Central Puget Sound Low Flow Survey reportas flow-impaired for salmon and steelhead (Lombard and Somers 2004), or have no major water withdrawals that would make them a priority for source exchange.

The objective of the prioritization below is to identify streams where source exchange has the potential to improve flows and associated water temperatures, and thereby help increase the abundance and distribution of salmon and steelhead populations. Because the summer flow of most streams in WRIAs 8 and 9 comes from groundwater seeping into streams at about 50 °F (10°C), restoring groundwater contributions to streams has the potential to enhance both the quality and quantity of instream habitat, and help

[1] The Committee felt it was important to get started in WRIA 8 and 9 to address urgent needs and concerns given the intensive urban and water resources development in these basins. Prioritizing streams in Pierce and Snohomish county watersheds for source exchange is encouraged but will require involvement from different tribes, individuals, and organizations.

mitigate the trend toward warmer water temperatures in local watersheds. It should be noted however that source exchange by itself is not capable of satisfying all instream flow needs for fish. Source exchange does not diminish the importance of other activities to protect and restore more natural flow regimes, water temperatures, and riverine habitats in all streams by preventing and reversing degradation by certain land uses and excessive surface or ground water withdrawals. Examples of these other important activities include:

- Adaptive management of groundwater supplies, reservoir storage and diversions to minimize impacts on natural stream flow
- Protection and restoration of upland, riparian and in-channel habitat features, functions and processes
- Instream flow agreements including FERC agreements, tribal agreements, or Habitat Conservation Plans
- Water conservation and efficiency programs
- Enforcement of water laws
- Development and enforcement of effective land use regulations and incentives
- Wetland and aquifer recharge area protection programs
- Water right permit review
- Adoption or implementation of state instream flow protection programs and standards
- Implementation of existing basin or stream closures
- Restoration of riparian vegetation and shading of exposed water
- Restoration of geomorphic channel complexity to expand habitat and enhance hyporheic[2] exchange with surface waters
- Restoration of wetlands and re-saturation of shallow aquifers where land use alterations have drained and lowered groundwater storage

Background

For several decades, several groups, agencies, utilities, and the Muckleshoot Indian Tribe have been working to protect and enhance stream flows or to develop information about low flow problems for aquatic resources in the Cedar-Sammamish-Lake Washington and Green-Duwamish watersheds. Recent efforts include water quantity assessments and salmon habitat limiting factors reports prepared for watershed planning groups as part of salmon recovery plans, as well as Habitat Conservation Plans in the Cedar and Green River watersheds. Numerous technical reports about water quantity, groundwater-surface water interactions, and salmon recovery needs were available to the Tributary Streamflow Technical Committee as background information, in addition to the professional expertise of participating state agency, tribal, and utility and local government biologists and hydrogeologists.

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[2] The saturated zone under and adjacent to a river or stream, consisting of sediments with interstitial spaces filled with water.

The Cedar-Sammamish-Lake Washington and Green-Duwamish are the most densely populated river basins in the state. Municipal, domestic, and irrigation water supplies have historically come from withdrawals of groundwater and surface water from streams, rivers, or lakes. In many cases, these withdrawals have diminished the quantity and quality of fish habitat, or have exacerbated natural low flow problems (Lombard and Somers 2004). As growth and development continue, the potential for further habitat degradation and conflict between instream and out-of-stream water needs will also increase.

The Committee primarily focused on the annual summer-fall low flow period from July through October. Information for some areas suggests that a longer period of concern, beginning in March or April and ending in October, may be appropriate due to low flow impacts on survival of specific life-stages for salmon or steelhead. In addition to low flows, elevated water temperatures are also a concern for some streams. For instance, summer-fall temperatures in the Sammamish River and in the Ship Canal have approached or exceeded lethal and sublethal effects thresholds during adult salmon migration (KCDNRP 2002). Streams where both flow and temperature limit the survival or productivity of salmon, and where withdrawals are reducing instream flows, were ranked higher by the Committee as candidates for source exchange.

Committee members recognized that water extraction is not the sole influence on stream flows or increased water temperature. Land development has caused the redistribution of water from winter base flow to storm flow as a result of impervious surface, loss of wetlands and permeable soil, land filling, and drainage facilities that impede aquifer recharge and accelerate runoff from land surfaces (Konrad and Booth 2005). Although land development is suspected to cause summer base flows to decline, this phenomenon has not been observed directly, likely due to the complications of inter-basin water transfers (Konrad and Booth 2002). Inadequate shade due to loss of riparian vegetation as well as channel modifications that restrict exchange between stream and their floodplains cause elevated water temperatures. Actions that restore and increase riparian shade, the complexity of channel morphology, habitat diversity (e.g., pools, large wood, cover, and side channels) and that promote recharge and interactions of streams with their floodplains are all urgently needed (WRIA 8 2005). The Committee recommends that these other habitat improvement actions be pursued vigorously by various entities in addition to source exchange projects as part of salmon recovery and other environmental stewardship initiatives.

Current degraded fish habitat conditions are typically the result of the cumulative effects of many actions. Improving fish habitat often requires combinations of both short and long term actions as opposed to single actions. Rather than being alternatives to one another, actions that restore flows (which this Committee focused on), and actions to improve other habitat attributes such as pools, riparian vegetation, channel diversity, and hyporheic exchange are essential and complementary in order to help recover and sustain salmon and steelhead populations.

Process

The Tributary Streamflow Committee held a series of eight meetings from February through July 2006. Participants included those listed below:

Steve Hirschey, Washington Department of Ecology
Kirk Lakey and Carl Samuelson, Washington Department of Fish and Wildlife
Mike Mactutis and Kelly Peterson, City of Kent
Jane Lamensdorf-Bucher, Hans Berge, and Tom Nelson, King County
Kit Paulsen, City of Bellevue
Rand Little and Keith Kurko, Seattle Public Utilities
Holly Coccoli, Carla Carlson, Brian Footen, and Eric Warner, Muckleshoot Indian Tribe
Keith MacDonald, City of Redmond
Geoff Clayton, Woodinville Water District and NE Sammamish Sewer and Water District, and Union Hill Water Association
Paul Hickey, Tacoma Public Utilities

The tributary ranking process began with a list of 20 candidate streams in WRIAs 8 and 9 (Table 1). These streams were identified in the Central Puget Sound Low Flow Survey report (Somers and Lombard 2004) as being flow impaired. The list was modified and some streams were added or deleted based on Committee insight and concurrence. A map of the candidate streams is provided in Appendix A.

Table 1. List of candidate streams to be prioritized for source exchange/substitution purposes.

Cedar R-Sammamish-Lake Washington Basin (WRIA 8)	Green-Duwamish River Basin (WRIA 9)
Lake Washington Ship Canal	Big Soos Creek
Sammamish River	Covington Creek
Bear Creek	Jenkins Creek
Cottage Lake Creek	Newaukum Creek
Evans Creek	Lower Green River (Below Howard Hanson Dam)
Little Bear Creek	Upper Green River (Above Howard Hanson Dam)
North Creek	North Fork Green River
Issaquah Creek	
East Fork Issaquah Creek	
North Fork Issaquah Creek	
Lower Cedar River (Below Landsburg Dam)	
Rock Creek (Below Landsburg Dam)	
Taylor Creek (Below Landsburg Dam)	

RANKING CRITERIA

Twelve ranking criteria in three main categories were rated in a spreadsheet matrix to develop relative priorities among the candidate streams within each WRIA for source exchange. The prioritization matrix adopted criteria for stream flow protection and enhancement developed by the Department of Ecology and Washington Department of Fish and Wildlife (Memorandum to Puget Sound Shared Strategy Water Quantity Committee entitled, *"Methodology for WRIA based ranking of Puget Sound streams for flow enhancement"*, March 24, 2006). Modifications to this methodology were made to reflect local conditions including thermal migration barriers and observed pre-spawning mortality. The main categories were 1) Relative Biological Importance; 2) Hydrologic Need; and 3) Probability of Measurable Benefit. Opportunity or acceptability of source exchange/source substitution was not used as criteria for ranking streams. It is expected that these considerations will be addressed in the Source Exchange Committee.

Category 1: Relative Biological Importance[3]

1. Pre-spawning adult mortality
2. Adult migration delay
3. Percent of the Chinook population in the WRIA present in the stream

   Spawning ground counts for Chinook are more widely available than for other salmon and these data allowed for the best comparison of abundance since nearly all of the candidate streams are used by Chinook. Both hatchery returns and naturally spawning Chinook were included.
4. Total number of listed anadromous fish species present
5. Total number of other anadromous fish species present

   Resident cutthroat and rainbow trout were not included because counting resident fish would not help discriminate among streams.
6. Juvenile rearing capacity or survival limitations due to low flows

Category 2: Hydrologic Need

7. Potential flow depletion indicator. *The ratio of estimated existing withdrawals to current summer-fall low flow was used as an indicator to compare relative hydrologic need among streams where other estimates of actual flow depletion were not available. Total instantaneous water rights of large municipal suppliers (Appendix C) were used to estimate withdrawals where other data were not available. Note that this factor was not intended to suggest that a detailed or definitive water balance assessment was conducted for each stream.*

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[3] Relative importance under current conditions. Relative importance may change in the future in response to changes in fish distribution and abundance, for example, as a result of fish passage projects.

Category 3: Probability of Measurable Benefit/Bang for Buck

8. Predicted hydrologic response

   Intended to discriminate according to stream size relative to the conceivable amount of flow that could be restored by source exchange in the short term (a few cubic feet per second in most cases); smaller streams will benefit proportionally more from restoring a few c.f.s. compared to larger streams. For comparison purposes, the Committee used a flow restoration threshold of 2 c.f.s. to estimate the percentage increase in summer low flow that would result. If a higher flow rate was used reflecting greater amounts of source exchange or substitution sources that potentially may be available in the long term, e.g., reclaimed water, the rankings for some streams would change.

9. Predicted thermal response

   Intended to discriminate according to where restoring water, especially groundwater, is likely to help alleviate temperature problems or expand thermal refuge areas, in combination with other actions e.g., riparian shade and channel improvement.

10. Channel condition *(the better the habitat quality, the higher the score)*

11. Added benefits to downstream reaches

    Intended to discriminate among streams according to the degree that flow restoration would likely benefit downstream fish habitat for either water quantity or temperature.

12. Multiple problems addressed *(fish passage, temperature, water quantity)*

Participants ranked each of the above factors (maximum score of 5 points per factor) for each stream, and noted data sources or rationale for scoring. Not all participants submitted rankings, some submitted rankings for only those streams for which they had knowledge, and some deferred to the rankings of others.

An effort was made to standardize the application of the criteria among participants so that the same approach or information sources were being used as much as possible. For example, in criterion No. 8, predicted hydrologic benefit, the recommended guidance was to use a flow restoration rate of 2 cubic feet per second (c.f.s.) as this is a fairly common flow rate for some municipal wells (about 900 gallons per minute). Criterion No. 8 favored ranking smaller tributaries over larger streams since restoring 2 c.f.s. would be a more significant proportional increase in of summer low flow in a small tributary than in a larger stream. It should be noted that the Committee did not intend to limit potential flow restoration to this amount, but used 2 c.f.s. as a common reference for ranking. Category 3 rankings could be revisited in the future as larger quantities of water become available for source exchange or substitution, such as through reclaimed water projects.

The total scores for each stream in each of the three main categories were then converted into a High (H), Medium (M), or Low (L) value by splitting the spread of the scores into thirds. The three main categories (Relative Biological Importance, Hydrologic Need, and Probability of Measurable Benefit) were equally weighted. The order of the ratings below is not significant, it is just a list of the possible combinations.

The results were assembled into the following 5 groups of relative priority <u>for the purpose of further discussion</u>:

1. Highest Likelihood of Benefit = H,H,H or H,H,M
2. Moderately High Likelihood of Benefit = H,H,L or H,M,M
3. Moderate Likelihood of Benefit = H,M,L or M,M,M
4. Low Likelihood of Benefit = H,L, L or M,L,L, or M,M,L
5. Poor Likelihood of Benefit = L,L,L

This final discussion step served as an important "reality check", and also to acknowledge that the prioritization matrix scores do not imply a numeric level of accuracy since such accuracy does not exist. This step ultimately resulted in several streams being moved up or down in priority.

Results

Based on the 12 ranking criteria in three main categories (Table 2) and the subsequent discussion step, the Committee identified the following relative priorities of streams for flow restoration.

Table 2. Results of tributary prioritization effort for source exchange.

	Relative Biological Importance[4]	Hydrologic Need	Probability Of Measurable Benefit
Cedar-Sammamish-Lake Washington Basin			
1. Highest Likelihood of Benefit			
Bear Creek	M	H	H
East Fork Issaquah Creek	H	H	M
2. Moderately High Likelihood of Benefit			
Issaquah Creek	H	M	M
Rock Creek	L	H	H
3. Moderate Likelihood of Benefit			
Sammamish River[5]	H	M	L
North Fork Issaquah Creek	L	H	M
Cottage Lake Creek	M	L	H
4. Low Likelihood of Benefit			
Cedar River	M	L	L
Taylor Creek	M	L	M
Little Bear	L	L	H
North Creek	M	L	M
Evans Creek[6]	L	H	M
Ship Canal	H	L	L
5. Poor Likelihood of Benefit			
None			
Green-Duwamish River Basin			
1. Highest Likelihood of Benefit			
Covington Creek	L	H	H
Jenkins Creek[7]	L	M	H
Big Soos Creek	H	H	M
2. Moderately High Likelihood of Benefit			
North Fork Green River[8]	L	M	H
Newaukum Creek	M	M	H
3. Moderate Likelihood of Benefit			
Lower Green River	H	M	L
4. Low Likelihood of Benefit			
None			
5. Poor Likelihood of Benefit			
Upper Green River	L	L	L

[4] Relative importance is for purposes of source exchange only. See ranking criteria 1 through 6 on Page 7.
[5] Elevated temperatures are a major concern in the Sammamish River and reducing groundwater withdrawals at multiple locations would be an important strategy to increase thermal refuge areas for fish. Ranking guidance affected the ranking of this stream. See discussion.
[6] Final ranking adjusted downward by Committee, see discussion.
[7] Final ranking adjusted upward by Committee, see discussion.
[8] There was a wide discrepancy in scoring and disagreement over the ranking of the North Fork Green River. Please see Appendix D for further explanation.

Rationale for Cedar-Sammamish-Lake Washington Basin Results

Bear Creek ranked in the highest category for source exchange for a number of reasons. It is an important contributor to natural production for sockeye, Chinook, and coho salmon, and has a high estimated hydrologic need based on the ratio of potential groundwater withdrawals to summer base flow (16 c.f.s. municipal water rights/22 c.f.s. median August flow). Low flow barriers and delay of upstream migration at low flow have been observed in Bear Creek (Brian Footen, MIT spawning survey crew, personal comm.). Like all streams not fed by a large lake or snowmelt, the summer base flow of Bear Creek comes entirely from groundwater, and thus ground water reservoirs are critically important for providing cool water. The mouth of Bear Creek is typically 5.5 °C (10°F) cooler than the Sammamish River during summer, temporarily lowering the Sammamish River temperatures by 2 – 3 °C below the confluence (KCDNRP 2002). The mouth of Bear Creek is also important for providing a thermal refuge especially for early-migrating adult Chinook and sockeye salmon in the upper Sammamish River during late August and early September when river temperatures continue to exceed levels at which sub-lethal or lethal effects occur.

The East Fork of Issaquah Creek ranked high for source exchange because of the large numbers of Chinook and sockeye spawning in the creek as well as holding at the mouth of the creek before moving upstream in Issaquah Creek to spawn or return to the Issaquah Creek Salmon Hatchery. Migration delay and pre-spawning mortality are suspected factors at low flows. The East Fork of Issaquah Creek also has a high estimated level of flow depletion based on numerous large wells and median August flows of about 4 c.f.s. The Issaquah Creek mainstem ranked moderately high because of the large number of salmon using the creek. Adult migration delay is observed at the creek mouth in Lake Sammamish at low flows, and pre-spawning mortality of adults has been observed in the creek.

Rock Creek ranked as Moderately High Likelihood of Benefit due to a high estimated level of hydrologic need based on water withdrawals of approximately 6 c.f.s. to a current median October baseflow of 1.4 c.f.s. These flows are based on data from 1986 to 1998 (City of Kent, 2005). The City of Kent has been voluntarily augmenting Rock Creek flows during the critical low flow period since 1998. Low flow issues are currently being studied and addressed by Kent through the HCP and an Environmental Impact Statement through consultation with the Federal Services. Low flows in lower Rock Creek at times have been suspected to delay the upstream migration of adult salmon. Stream habitat conditions of Rock Creek are considered good to excellent (WRIA 8 2005).

The Sammamish River ranked in the third category, Moderate Likelihood of Benefit, based on a high relative biological importance and significant flow depletion. The Sammamish River is a vital migration corridor and ecological link between the watersheds of Lake Sammamish and Lake Washington. A large proportion of the salmon populations of WRIA 8 utilize the Sammamish River given the Issaquah Creek Salmon Hatchery production and natural salmon production in Sammamish River tributaries.

Hydrologic need was rated medium based on 36 c.f.s potential withdrawals by municipal water suppliers within the river basin compared to a median summer flow of 90 c.f.s.. A 20-year low flow event of about 30 c.f.s. occurred in fall 1994.

Elevated water temperatures are an increasingly urgent threat to salmon in the Sammamish River, with daily maximum temperatures that frequently exceed 68°F (20°C) in the upper river and occasionally have exceeded 80°F (26.6°C) (KCDNRP 2002). Summer and early fall water temperatures in the Sammamish River are well within the range of those causing adverse physiological and behavioral effects, and are frequently in the lethal range during July and August.

Salmonids respond not only to daily maximum water temperatures, but also to maximum daily fluctuation, maximum mean temperatures, and cumulative exposure history (Berman 1998). After surviving elevated temperatures in the Lake Washington Ship Canal, Chinook and sockeye enter the Sammamish River beginning in mid to late August. Radio tracking studies found that the average entry date for tagged adult Chinook in 1998 (mean September daily maximum temperature of 21.1°C) was September 21 compared to September 12 in 2000 (mean September daily maximum temperature of 19.8°C) (Fresh, K.L. et al., 1999 and E. Warner, Muckleshoot Indian Tribe, unpub. data). Chinook and sockeye migration timing in the Sammamish River coincides with temperatures that have both lethal and sub-lethal effects. Sublethal effects may include migration delay, increased depletion of body fat reserves, disorientation, egg retention, production of abnormal embryos or alevins, high fry or alevin mortality, increased vulnerability to disease of adults and offspring, and other physiological problems (Berman and Quinn 1991 and 1989). For example, as energy reserves are important to successful reproduction, elevated temperatures during migration can directly affect population and species viability (Berman 1998). Tagged Chinook spent an average of 7 (in 1998) and 9 days (in 2000) in the Sammamish River, although some individuals held in the river for as long as 31 days. A delay in upstream migration of only 5 days caused significant mortality in Fraser River sockeye salmon. Few of the salmon reached the spawning grounds when subjected to delays of 10 to 12 days (Snyder and Blahm 1971). Temperatures above 70°F (21°C) are reported to equal or exceed lethal temperatures for Chinook (McCullough 1999). Spence et al. (1996) cite 26.2°C as the upper lethal temperature for chinook salmon acclimated to 20°C while Brett (1952) reports an upper lethal temperature of 25.1°C. Pre-spawning mortality of adult salmon has been documented in the Sammamish River in 1998 (Fresh et al. 1999) and in 1999 (Tabor 2002).

Tributary and groundwater inflows serve as a cooling influence on the Sammamish River (Cary 2003) and likely provide critical local thermal refuge for salmon. The Sammamish River would likely have ranked higher except that prioritization criteria No. 8, 9, 11 and 12 favored smaller tributaries when predicting the likelihood of measurable benefits. This was largely because of the Committee decision to use a 2 c.f.s. increment of flow restoration to compare and predict hydrologic and thermal benefit among streams. When applied to the Sammamish River, the 2.c.f.s. criterion results in a relatively small increase in the percentage of stream flow and a small decrease in summer temperatures. It should be noted that, if a higher magnitude of flow restoration had been used, the overall ranking for the Sammamish River would have been higher. For example, river temperature modeling scenarios conducted for the Sammamish River Corridor Action Plan indicated that an additional 15 c.f.s. of groundwater delivered to the river between Redmond and Woodinville would reduce thermal stress during the August-October migration period even more than the scenario based on a 25 percent reduction in incoming solar radiation through riparian shade (KCDNRP 2002, Appendix B).

The Committee recognized that inadequate riparian canopy along the Sammamish River and its tributaries elevate water temperatures through solar radiation. Increasing cool groundwater inputs along the river would help mitigate the elevated temperatures inherited from Lake Sammamish, however, multiple actions are required to reduce water temperatures in the Sammamish River. Restoring tributary and groundwater inflows along the Sammamish River by source exchange projects, planting riparian vegetation, restoring wetlands, and re-meandering the river channel to intercept groundwater and hyporheic flow are all vital to re-establish cooler water temperatures suitable for salmon survival (WRIA 8 2005). Re-meandering the slough at Marymoor could be investigated as a way to contribute to reducing the severe thermal migration block in the reach of the Sammamish River between Bear Creek and Lake Sammamish.

The North Fork Issaquah Creek was also ranked in the third category along with Cottage Lake Creek. The North Fork of Issaquah Creek experiences very low summer-fall flows (less than 1 c.f.s.) and flow depletion was assumed to be significant due to several large wells in proximity to the creek. Spawning surveys indicate low numbers of salmon using the creek under current conditions and an impassible natural barrier located near river mile 1.3 (Williams and Ames 1975). Flow restored in the North Fork of Issaquah Creek would incrementally improve attraction and habitat conditions in lower Issaquah Creek. Cottage Lake Creek was ranked in the same category although it ranked low for hydrologic need because it is not affected by large groundwater withdrawals. Cottage Lake Creek otherwise has relatively good fish habitat conditions, and fish passage access for adult Chinook and other salmon would be improved with additional flow.

The lowest category within WRIA 8 (Low Likelihood of Benefit) included the Ship Canal, Cedar River, Taylor, Little Bear, North, and Evans creeks.

The Lake Washington Ship Canal is a critically important migration corridor for all anadromous fish in WRIA 8 because they all must migrate through this waterway as adults and juveniles. Warm water temperatures in the Ship Canal threaten the survival and affect the reproductive success of all anadromous fish migrating into the basin. Adult mortality and a thermal barrier to smolt migration have been observed at the Ballard Locks at times. However, beyond making a small incremental contribution to water supply for fish passage in the operation of the smolt flumes and in fish ladder attraction flow at the Ballard Locks – the Committee was less certain that flow restoration from source exchange was likely to measurably improve temperatures, dissolved oxygen, and other limiting conditions for adult and juvenile fish migration in the Ship Canal from late spring through early fall. Restoring water in the higher ranked tributaries located upstream would provide greater benefit, and at the same time, would also provide an increment of improvement to the quantity of water available for fish passage at the Locks. Other types of measures besides source exchange are urgently needed to address poor fish migration conditions in the Ship Canal and at the Locks.

Evans Creek, a tributary of Bear Creek, ranked low because of its relatively low biological importance and the low likelihood of measurable benefit of an additional 2 c.f.s. to the creek itself or downstream. Although Evans Creek was rated high for hydrologic need, the Committee adjusted its final ranking downward because of limited salmon spawning habitat, especially for Chinook, due to low stream gradients and mainly fine-grained substrate unsuitable for spawning. The upper reaches, particularly Rutherford Creek, have some gravel that support the spawning of coho salmon and cutthroat trout. Despite these limitations, Evans Creek is a very productive stream for coho salmon (Seiler et al. 2005). The broad, agriculturally modified open wetlands provide forage and overwintering habitat for coho but are also areas of significant solar heating. The degraded wetlands and low gradient of lower Evans Creek also results in a low rate of flow that is dispersed. Simply adding water without increasing shade or improving channel geomorphology may result in more warm water entering Bear Creek. There are currently no data indicating that low flow or thermal conditions cause pre-spawning adult mortality, adult migration delay, or limits on the survival of juvenile salmon in Evans Creek. The average August flow is about 4 c.f.s. in Evans Creek.

The Cedar River ranked as having a Low Likelihood of Benefit because of a relatively low hydrologic need and a low likelihood of measurable benefit in part because of its larger stream size, although it is a very important stream for anadromous fish in the basin. Taylor, Little Bear, and North creeks had a low hydrologic need in terms of having no major wells or withdrawals, and either low or moderate relative biological importance and likelihood of benefit.

None of the candidate streams in the Lake Washington Basin ranked as having a Poor Likelihood of Benefit.

Rationale for Green-Duwamish Basin Results

The Green River tributaries Covington, Jenkins, and Big Soos Creek all ranked as having the Highest Likelihood of Benefit within WRIA 9 for flow restoration through source exchange. The Soos Creek watershed is very important to Chinook, coho, and steelhead in the basin, both for natural production and for fish produced at the WDFW Soos Creek Hatchery. Low summer and fall flows are observed to delay Chinook migration at the mouth of Big Soos Creek. Low summer flow and water withdrawals have long been considered a major limiting factor to salmon production in the Soos Creek watershed (Williams et al. 1975). Hydrologic need is high. Total well extractions compared to current condition stream flows in Covington, Jenkins, and Big Soos creeks are estimated at 78%, 45%, and 43% of median August low flows, respectively (Northwest Hydraulic Consultants, Inc. 2005). Existing instantaneous quantity (Qi) water rights held by the large municipal suppliers for the Soos Creek watershed total 22.5 c.f.s. which amounts to

96% of the existing 1 in 10 year low flow for the month of August (Water Years 1967-2004). The likelihood of measurable benefit was considered high for flow restoration based on predicted hydrologic and thermal response, the relatively good condition of habitat, and the potential to improve fish passage as well as habitat quantity and quality. Although Jenkins Creek was rated low for relative biological importance based on criteria weighted toward chinook presence and abundance, and incidence of pre-spawning mortality, it's final ranking was adjusted upward because of its position in the stream network and the broad distribution of coho salmon and steelhead in the creek. Restoring water to Jenkins Creek would simultaneously benefit downstream reaches in Big Soos Creek that are critical to chinook and steelhead.

Newaukum Creek and the North Fork Green River were both ranked as having a Moderately High Likelihood of Benefit for source exchange. Newaukum Creek is important for natural production of coho, steelhead, and Chinook. Spawning ground counts of Chinook and steelhead are greater in Newaukum Creek than in any other tributary to the Green River, except for the Soos Creek drainage. The mouth of the creek is impassible at low flows, causing delay of adult Chinook migration. Total well extractions are estimated at 17% of median August low flows ((Northwest Hydraulic Consultants, Inc. 2005). The total existing instantaneous quantity (Qi) water rights for large municipal wells in the Newaukum watershed represents 93% of the 1 in 10 year low flow for the month of August (12.4 c.f.s/13.3 c.f.s.). There was a wide discrepancy in scores and disagreement over the ranking of the North Fork Green River among participants (see Appendix D for further explanation).

The likelihood of measurable benefit was ranked as moderate for flow restoration based on predicted hydrologic and thermal response, the relatively good condition of habitat, and the potential to improve fish passage as well as habitat quantity and quality.

The lower Green River was rated as having a Moderate Likelihood of Benefit for source exchange. The Upper Green River was ranked as having a Poor Likelihood of Benefit for source exchange given low scores for hydrologic need (there are no wells or diversions in the Upper Green River), relative biological importance according to the criteria used, and poor likelihood of measurable benefits.

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