Muckleshoot Indian Tribe Fisheries
Technical Input

Central Puget Sound Water Supplier's Forum
Drought Response Committee 2001

June 20, 2001

Attachment 1

MIT Drought Response Technical Input

June 20, 2001

Priority Rivers and Streams

WRIA 8
Cedar-Sammamish-Lake Washington

Ballard (Chittenden) Locks and Ship Canal
Cedar River
Sammamish River
Bear-Evans Creek (and Cottage Lake Creek)
Issaquah Creek (and East Fork Issaquah Creek)

WRIA 9
Green-Duwamish

Green River
Soos Creek (and Jenkins Creek)
Newaukum Creek

WRIA 10
Puyallup-White River

Puyallup River
White River
Boise Creek

Problems

Low Flow

Low flows in the Cedar-Sammamish River, Green-Duwamish River, and Puyallup-White River systems were recognized in the mid-70s as limiting factors to salmon production (Williams, et al, 1975). Due to low flow concerns in WRIA 8, the Department of Ecology administratively closed most surface water bodies upstream of the Ballard (Chittenden) Locks to further consumptive surface water right appropriations and set minimum instream flows on the Cedar River in 1979 (Chapter 173-508 WAC). Ecology determined that additional diversions of water from the Lake Washington drainage system would deplete instream flows and lake levels needed to support beneficial uses, including flows for salmonids (Chapter 173-508-030). Also due to low flow concerns on salmon, minimum instream flows were set on the Green River and tributaries were

closed to further appropriations per Chapter 173-509. Similar concerns prompted flow setting for several sites on the Puyallup River and one on the Carbon River with closures and limitations set for tributaries (such as the White River) per Chapter 173-510. Ecology also conducted watershed assessments that documented low flow declines and acknowledged low flow problems on fish resources (Ecology's watershed assessments for WRIAs 8, 9, and 10).

Impacts of low flow on salmon and steelhead spawning include reductions in suitable spawning, incubation, and rearing habitat; impairment of upstream migration, increased water temperatures, increased susceptibility to other water quality problems, increased predation as well as other adverse effects. These impacts can lead to prespawning mortality or loss of egg viability. In fact, there is recent evidence that excessive heat stress on salmon eggs leads to teratogenic impacts that are carried on in future generations. Coho salmon juveniles exposed to low summer streamflow conditions have been found to return in fewer numbers as adults (Smoker, 1955; Matthews and Olson, 1980). Low flows also contribute to predation of juveniles due to the concentration of predators and prey in less water volume, usually with less cover, coupled with the slower outmigration timing due to decreased water velocities. For example, WDFW documented that predation of juvenile sockeye in the Bear Creek system resulted in losses of 135,000 outmigrants in one night -March 14, 2001 (personal communication, Gary Sprague, WDFW). This predation continued for this very dry outmigration season except for those periods of normal flows (i.e. – after rain). It should be noted that Cottage Lake Creek, a tributary to Bear Creek, is an important salmon production stream. In the last few years it has consistently had more chinook spawners in its three miles than in the 20 accessible miles on the Cedar River. It also has substantial numbers of sockeye every year.

Issaquah and the East Fork of Issaquah are also important sockeye and chinook production streams. For example, tribal biologists conducted spawning surveys during October of 2000 and found several thousand live sockeye adults and carcasses. Survey estimates suggested ten thousand sockeye were present in the East Fork and mainstem Issaquah. These streams also suffer from low flow problems.

Flows at the Ballard Locks are a limiting factor to salmonids. Flows limit both adult passage into the Locks and juvenile outmigration. In recent years, the COE has sought to improve the situation by installing slides to assist outmigrants. However, the COE cannot run the slides without available water and therefore the slides have been turned off before the end of the juvenile salmon outmigration to maintain lake levels in the fall. This will result in the mortality of chinook, sockeye, and coho smolts, but chinook, with the latest outmigration timing are impacted the most severely. Upstream migration of adults is hampered by Lock operations – in low spill years, the fish find it difficult to find their way through and exert extra energy in the search for the fish ladder entrance. Limiting freshwater flows into the estuary between the Locks and Puget Sound makes the transition from saltwater to freshwater very difficult for migrating adults. Water quality problems (high temperatures and low dissolved oxygen levels) through the ship canal are problematic for adults migrating upstream into the Lake Washington system. Estimated flows through the Ship Canal have dropped below 160 cfs in low water years. In dry years the estuary is constrained to a very small area below the fish ladder and the Locks. The freshwater fish ladder flow, at 23° C, is much warmer than the saltwater below (13° C). The osmotic shock for chinook adults making this transition is often fatal. Even if they make their way upstream, they must wait for sufficient flows, cool temperatures, and higher dissolved oxygen levels before moving upstream into the lakes. In past years tagged chinook have often been effectively confined to the small, relatively cooler and saltier area immediately upstream of the large lock chamber for over a month. Mortalities for both adults and juveniles for all salmonid species are severe.

Low flows are also problems in the Cedar, Green, Sammamish, White and Puyallup Rivers, throughout the Soos Creek system, Newaukum Creek, and Boise Creek.

Temperature and Water Quality

Elevated summer water temperatures negatively affect salmon production, especially in the Sammamish River. Natural processes for groundwater inflow to Lake Sammamish and the Sammamish River should be protected as groundwater provides important contributions of cold water to help moderate high temperature and to provide thermal refuge areas for fish. In the last warm, dry summer, 1998, hundreds of adult chinook died prematurely in the Sammamish River, likely from heat stress (parts of the river reached 28° C). Even fish returning to hatchery ponds in the system were predisposed to prespawning mortality, a delayed legacy of their time in the Ship Canal and/or the Sammamish River. The combined effect of declining low flows in the Sammamish River, Lake Sammamish levels and reduced flows in other Lake Washington tributaries causes a net decline in seasonal inflow at the Corps of Engineers Chittenden (Ballard) Locks. Fish passage, navigation, and salinity control operations at the Locks depend upon lake storage maintained by basinwide inflows. Temperature and water quality are also limitations in the Cedar and Green Rivers.

Stream Capture by Wells Contribution to Low Flow Problems

Ground water development in the Puget Sound lowlands will, in most cases, affect the baseflow to streams (Morgan and Jones, 1996). Groundwater extraction generally reduces streamflow with the timing of impact on the order of days, weeks, or months rather than years (Massmann, J., Jan. 2000; Massmann, J., Oct., 2000; Massmann, J. Feb. 2001). Long term pumping of groundwater depletes stream flow and/or lake levels by induced leakage from overlying aquifers or water bearing zones that discharge to surface waters as well as by the direct interception of groundwater that would otherwise flow to surface water bodies (Massmann, J. PCHB testimony, Wildrick, L., PCHB testimony). Most modern hydrogeologists accept the interconnection between groundwater and surface water as scientifically valid. The Technical Advisory Committee, convened by the Department of Ecology, agreed that "in the long run, any ground water withdrawal will reduce ("capture") surface water flow in one or more hydraulically connected water bodies . . ." (Draft, Report of the Technical Advisory Committee on the Capture of Surface Water by Wells, 1998). Ecology also accepted this scientific principle when the Department denied many applications for new groundwater rights in WRIAs 8, 9, and 10 in 1996. Ecology determined that further groundwater withdrawals would impair existing water rights as streams and rivers closed to further appropriations in these watersheds and statutory instream flows of the Cedar, Green, and Puyallup rivers would be impaired. It was also recognized that this impairment would adversely impact fish resources. The Washington State Supreme Court (*Postema and Jorgenson vs. Pollutions Control Hearings Board, et al., No. 67549-0*) upheld this view and recently affirmed that where a groundwater withdrawal would diminish flows where regulatory instream flows are often not met and/or where tributaries have been closed to further appropriations, that a water right should not be issued.

Because of the leaky nature of the aquifer systems in the Bear-Evans Creek, Issaquah, Sammamish, and Soos Creek watersheds, there is hydraulic continuity between the aquifers and the lakes, streams, and springs in the basin (Massmann, October, 2000, February 2001, and January 2000). Water extracted by groundwater wells is water that would have fed streams and other surface water bodies.

The time lag between groundwater extraction and streamflow reduction is expected to be relatively short in the Bear-Evans Creek, Sammamish River, Issaquah, and Soos Creek watersheds. This is likely also the case in the Cedar and Green River basins. The relatively permeable geologic materials and the close proximity of wells and streams cause these time lags to generally be on the order of days or weeks rather than months or years. In many cases, the impact on streams from groundwater extraction will be approximately equal to the pumping rate, particularly during the summer months. The groundwater studies carried out by the City of Auburn also support these statements for the lower Green River.

It should be noted that impervious and semi-pervious surfaces due to urbanization are also major contributions to summer and early fall baseflow losses.

Water Utility Inventory by Watershed

WRIA 8
Cedar-Sammamish-Lake Washington

Bear-Sammamish

City of Redmond
Northeast Sammamish Water and Sewer District
Union Hill Water Association
Cross Valley Water District

Four water utilities operate wells and withdraw groundwater from the Bear Creek (Bear-Evans) watershed: Cross Valley Water District withdraws water from the headwater watershed, Northeast Sammamish Water and Sewer District and Union Hill Water Association withdraw groundwater from the Evans Creek subbasin; the City of Redmond has shallow wells that affect Bear Creek near the mouth and the Sammamish River. According to their 1999 consumer confidence report, the City of Redmond has immediate plans or has already redrilled a replacement well with a capacity of 1.0 mgd or 1.5 cfs in the Sammamish River valley. **The Tribe strongly recommends that as part of the drought strategy, that Redmond put these plans on hold.**

Table 1 - Summary of Municipal Water Supply Wells in the Bear Creek Basin (Massmann, J. Oct. 2000)

	Pumped in 1990	Location	Depth	Elevations (ft)		Closest Stream/Distance
	(gallons)	(Qrt/S-T-R)	(ft)	Static	Screen	
Cross Valley 1	255,000	SW/24-27-5	191	318	249-269	0.8 mi., Bear Cr*
Cross Valley 3	22,000,000	NE/25-27-5	238	312	242-272	1 mi., Bear Cr*
Cross Valley 8		NE/25-27-5	244	312	236-306	1 mi., Bear Cr*
Cross Valley 7	13,400,000	SE/34-27-6				Out of basin
Cross Valley 7A	19,430,000	SE/34-27-6				Out of basin
Cross Valley 5	94,000,000	NW/24-27-5		314		1 mi., Bear Cr*
Cross Valley 6		NW/24-27-5	254	314	166-186	1 mi., Bear Cr*
Cross Valley 9		SW/24-27-5	300	314	145-184	0.8 mi., Bear Cr*
Cross Valley 10		NW/24-27-5	278	314	149-200	1 mi., Bear Cr*

*Bear Creek in Snohomish County

	Capacity	Location	Depth	Elevations (ft)		Closest stream/Distance
	(gpm)	(Qrt/S-T-R)	(ft)	Static	Screen	
Redmnd #1	1000	NW/12-25-5	56	33		Bear Cr., 1500 ft; Samm. R, 2000 ft
Redmnd #2	500	NW/12-25-5	72	30		Bear Cr., 1500 ft; Samm. R, 2000 ft
Redmnd #3	500	NW/6-25-6	44	47		Bear Cr., 1500 ft.
Redmnd #4	750	SE/2-25-5				Samm. R., 2000 ft
Redmnd #5	1000	NE/12-25-5	41	38	+10 to +25	Bear Cr., 1500 ft.

	Capacity	Location	Depth	Elevations (ft)		Closest Stream/Distance
	(gpm)	(Qrt/S-T-R)	(ft)	Static	Screen	
NE Samm. #2R	385	NW/21-25-6	150	94	+15 to +45	Evans, 2000 ft.

NE Samm. #3	585	SE/21-25-6	690	115	-198 to -148	Evans, 4000 ft.
NE Samm. #4	600	SE/21-25-6	388	127	+4 to +34	Evans, 3,000 ft.
NE Samm. #6	385	NW/21-25-6	156	91	-5 to +54	Evans, 1500 ft.

	Capacity	Location	Depth	Elevations (ft)		Closest Stream/Distance
	(gpm)	(Qrt/S-T-R)	(ft)	Static	Screen	
Union Hill #1	825	SE/16-25-6	236	150	-27 to -53	Evans, 1000 ft.
Union Hill #2	220	SE/16-25-6	220	149	+9 to +39	Evans, 1500 ft.
Union Hill #3	360	NW/10-25-6	496	187	+73 to +130	Evans, 1500 ft.

The total Qi water rights for the 4 water utilities that currently withdraw groundwater in the Bear-Evans/Sammamish River watershed are 17.3 mgd (Forum Outlook, draft, 2001) or 26.7 cfs. The lowest 7-day flow reported by the USGS for the Sammamish River near Woodinville gage is 29 cfs. Flows at the mouth of Bear Creek can reach as low as 18 to 20 cfs.

Issaquah Creek

Sammamish Plateau Water and Sewer District
City of Issaquah

Sammamish Plateau Water and Sewer District and the City of Issaquah withdraw groundwater from wells in the Issaquah Creek valley. Sammamish Plateau also operates wells on the plateau east of Lake Sammamish. Sammamish Plateau holds primary Qi water rights for 2 of the 3 wells in the valley that can be utilized during the summer period. They also hold primary and supplemental rights for winter and spring use for all 3 wells. Total Qi rights for each utility for these wells that affect the East Fork, North Fork and the mainstem of Issaquah Creek are 5.6 mgd or 8.7 cfs for the City of Issaquah (this includes rights of 1.2 mgd or 1.8 cfs for the Gun Club wells, which may not be operational at this time) and 4.6 mgd or 7.1 cfs for Sammamish Plateau.

Salmon can access both the East Fork and North Fork tributaries when flows are sufficient to provide access; however the East Fork is utilized much more heavily by salmon than the North Fork. Muckleshoot Indian Tribe biologists conducted spawning surveys in the North Fork and East Fork during October of 2000. On October 24th, 6 live sockeye adults and 3 sockeye carcasses were found in the North Fork, while 4467 live sockeye adults and 432 sockeye carcasses were counted in the East Fork on October 23rd. No chinook or coho adults were found in the North Fork and 5 chinook and 8 coho adults were found in the East Fork on that date.

Table 2 - Summary of Municipal Water Supply Wells in the Issaquah Creek Basin (Massmann, J. Feb. 2001).

	Capacity	Location	Depth	Screen Elevation (ft)	Closest Stream/Distance
	(gpm)	(Qrt/S-T-R)	(ft)	Screen	
Issaq #1	600	M/27-24N-06E	107	+3 to -13	E. Fork Issaquah Creek/300 ft
Issaq #2	1000	M/27-24N-06E	97	+12 to -3	E. Fork Issaquah Creek/300 ft
Issaq #4	250	B/28-24N-06E	112	-11 to -36	Main Stem Issaquah Creek/500 ft
Issaq #5	1000	B/28-24N-06E	412	-266 to -338	Main Stem Issaquah Creek/500 ft
SPWSD #7	2000	A/28-24N-06E	151	-12 to -77	N. Fork Issaquah Creek/100 ft
SPWSD #8	3500	A/28-24N-06E	190	-31 to -105	N. Fork Issaquah Creek/100 ft
SPWSD #9	2000	E/27-24N-06E	303	-116 to -141	N. Fork Issaquah Creek/900 ft.

Note: SPW&SD also has wells in the Sammamish Plateau upland east of Lake Sammamish that likely affect groundwater input into Lake Sammamish).

Total Qi water rights for summer use from both utilities, not including the Gun Club wells, that affect Issaquah Creek flows are 14 cfs. The annual 7-day low flow on the main stem of Issaquah Creek has ranged between 14 and 42 cfs. Low flows for the East Fork have been recorded as low as 1.3 cfs. **Because the City of Issaquah wells impact both the East Fork and the mainstem, it is recommended that any drought strategy especially target the City's supply.**

Cedar River

City of Seattle

As there is already much known about the City of Seattle's water supply operations and there is currently other processes for dealing with Cedar River flows (IFC, AFC), the focus here will be on other utilities that affect flows of the Cedar River; the City of Renton via their wells located in the Cedar River valley and the City of Kent with its diversion on Rock Creek. However, it is the Tribe's view that Seattle should implement very aggressive conservation measures for all its purveyors and curtail its withdrawals from the Cedar River as much as possible. We would also like to clarify here that any source diversion recommendations for utilities in need of new supplies for the drought should not come from expanded Cedar River withdrawals, but rather from other supplies where water is determined to be available as concurred to by the affected treaty tribe.

City of Renton Wells

According to the city's 1996 water system plan, Renton has nine wells located in the Cedar River valley with a combined approximate capacity of 26 mgd or 40 cfs. However, some or many of these rights are supplemental, so a more detailed review of Qi water rights from the Cedar River source should be conducted. Renton also has supplies of groundwater in the May Creek subbasin and for springs in the Green River basin (Springbrook Springs).

City of Kent - Rock Creek (Clark Springs facility)

According to Kent's 2000 water system plan, Kent has water rights for three shallow wells, an infiltration gallery to collect spring water, and for a surface water diversion from Rock Creek. The total Qi water rights are 11.0 mgd or 17.0 cfs and the rights for the wells are conditioned on minimum instream flows of Rock Creek: 15 cfs from Jan. 1 – Apr. 30th; 15 cfs May 1st – decreasing to 2 cfs by June 30th; 2 cfs from July 1st – Oct. 31; and 15 cfs from Nov. 1 to Dec. 31st. Kent has the means to discharge untreated water into Rock Creek to ensure these minimums are met. However, as the wells are screened to between 30 and 60 feet and are completed in the Qvr aquifer that discharges to Rock Creek, the Tribe does not support groundwater pumping as flow augmentation. The timing of impact from well pumping is relatively short and not likely to provide any significant benefit to flows of Rock Creek. In addition, such pumping may be detrimental in that groundwater would be removed that may otherwise provide much needed flows to Rock Creek later in the summer or early fall. The Tribe communicated our concerns with such flow augmentation during a meeting with the City in October 1997.

Kent also has spring and groundwater supplies in the Soos Creek basin (Covington Creek and Jenkins Creek) and wells in the Green River mainstem watershed.

WRIA 9
Green-Duwamish

Green River

City of Tacoma

Tacoma Public Utilities diverts surface water from the Green River and also has groundwater rights for wells located in the North Fork of the Green River. The City also operates well fields in the Puyallup River watershed and in south Tacoma. The well fields have been used in the past to provide alternative supplies to benefit salmon in the Green River. Interagency and tribal coordination has been initiated to address past droughts and will likely continue to be. Curtailment, source diversion, flow augmentation, and flow attraction have been utilized by the City to benefit salmon resources.

City of Auburn

Auburn operates and holds water rights for seven wells (Wells 1, 2, 3A, 3B, 4, 6, and 7) located in the Auburn valley between the Green and White rivers. According to Auburn's draft 2000 water system plan, the total Qi water rights for these well are 14.7 mgd (or 22.7 cfs). Auburn's groundwater studies and pumping tests have shown hydraulic connection between the Green and White rivers and production wells. For example, the following quote is from the Pacific Groundwater report:

> *"The hydraulic connection between the White and Green Rivers and the Qvrd Production Aquifer means that the development of additional groundwater must consider the flow regimes of both rivers. Because of this connection, pumping from wells in the Qvrd may affect flows in the rivers, which are regulated under WACs 173-509 and 173-510" (page 80, Pacific Groundwater Group, October, 1999).*

Additionally, the City's largest supply source is from Coal Creek Springs, tributary to the White River and the City has 2 wells in the Lake Tapps Upland. .

City of Kent

The City of Kent has several wells in the East Hill and upland area east of the Green River valley. Kent reports a total August average production of 4.2 mgd (6.5 cfs) from these wells.

City of Black Diamond

The City of Black Diamond utilizes springs tributary to the Green River as its supply source. Overflow from the springs discharge to the Green River on the south bank, downstream of the Gorge. These springs are crucial for providing cool water to the mainstem Green River that is warmed from storage behind Howard Hanson dam. The City's reported instantaneous water rights are 5.2 mgd or 8 cfs, however the City's latest water system reports a much lower usage, less than 3 cfs (City of Black Diamond Comprehensive Water System Plan, 1999) and the validity of the full 8 cfs Qi is in question.

Soos Creek

Covington Water District
City of Kent
KCWD #111

Covington Water District has two well fields that withdraw groundwater from the Soos Creek basin. The Lake Sawyer Well Field located north of Lake Sawyer is in the Covington Creek subbasin and the five production wells have a total Qi of 5.8 mgd or 9.0 cfs (Covington WD Comprehensive Plan, 1994). The Witte Well Field is located south of Wilderness Lake and withdraws water from the Jenkins Creek subbasin. Total Qi water rights for the four wells are 2.2 mgd or 3.4 cfs. Groundwater flow to the Soos Creek system is reduced by an amount equal to the pumping rate from the wells and the timing of impact is on the order of several weeks to several months after pumping commences (Massmann, J.

Jan. 2000). Covington has agreements with Auburn and Seattle to provide additional supplies.

The City of Kent withdraws water from springs and wells in the Jenkins Creek subbasin. The Kent Springs facility consists of 2 wells and an infiltration gallery. The wells produce about 1390 gpm (2 mgd or 3.1 cfs) or less on a continuous basis, but 3,690 gpm (or 8.2 cfs) can be pumped during winter. (City of Kent Public Works, 2000). Water rights and claims (Qi) for the springs and wells total 8178 gpm (11.8 mgd or 18.2 cfs). Kent also reports production problems from the wells and springs due to seasonal declines in the static water level of the Qvr aquifer. The City's Armstrong Springs facility consists of two wells that withdraw groundwater in the Jenkins Creek subbasin as well. Total Qi water rights are 1.9 mgd or 2.9 cfs. The wells are used for peaking, so it is assumed they are pumped at the full 1.9 mgd rate. The City also operates a well in the Soosette Creek subbasin with a total August average production rate of 0.7 mgd (or 1.1 cfs) (City of Kent Public Works, 2000).

Water District #111 has several production wells in the near Lake Meridian in the Soosette and mainstem Big Soos Creek and Jenkins Creek subbasins. Three wells are in backup emergency status per the Tribe's settlement agreement with the District. The District's Qi water rights of 2.8 mgd (or 4.3 cfs) are pumped from the remaining wells. The District's supply is also supplemented by the City of Auburn.

Table 3 - Total estimated summer/peak withdrawals from the Soos Creek basin for major water supply utilities

		PEAK MGD	CFS
KENT	Kent Springs	2.0	3.1
KENT	Armstrong Springs	1.9	2.9
KENT	Soos Cr. Well	0.7	1.1
	KENT TOTAL	**4.6**	**7.1**
WD #111	Wells 3, 5, 6, & 9	2.8	4.3
	WD #111 TOTAL	**2.8**	**4.3**
CWD	Lake Sawyer Wells	5.8	9.0
CWD	Witte Wells	2.2	3.4
	CWD TOTAL	**8**	**12.2**
	TOTAL CFS		**23.6**

Major summer groundwater withdrawals from the Soos Creek basin total about 24 cfs and the average annual 7-day low flow of Big Soos Creek near the mouth is 27 cfs. Jenkins Creek, tributary to Big Soos Creek, has flows as low as 11 cfs. The WDFW Green River Hatchery located near the mouth of Big Soos Creek has reported low flow problems for many years.

Newaukum Creek

City of Enumclaw

The City of Enumclaw apparently has Qi water rights for springs and wells in the Newaukum Creek subbasin of approximately 6.4 mgd or 9.9 cfs (City of Enumclaw 1993 Comprehensive Water System Plan, 1994). Newaukum Creek also experiences low flow and water quality problems that are exacerbated by these withdrawals. Newaukum Creek low flows have been recorded as low as 12 cfs.

WRIA 10
Puyallup-White River

White River
Boise Creek
Puyallup River

White River

City of Auburn

Total Qi water rights for Coal Creek Springs are 9.7 mgd or 15 cfs and Qi rights for Auburn's wells located on the Lake Tapps Upland are 1.7 mgd or 2.6 cfs. The Tribe and Auburn have a settlement agreement over the use of Coal Creek Springs, which Auburn states will reduce its available supply by 3.9 cfs (City of Auburn, 2000). In addition, some of Auburn's production wells in the Auburn valley also affect flows in the White River per the discussion above for the Green River.

White River flows are controlled by Puget Sound Energy's operations. A 1986 settlement agreement between the Tribe and PSE set a minimum flow of 130 cfs in the bypass reach. However, flows during the summer in the bypass reach have been set at 200 cfs per the interim flows agreed to in 1999 as part of the FERC Licensing Stay Order. If FERC approves a stay extension, summer minimum flows will be set at 250 cfs.

Cities of Pacific, Buckley, Bonney Lake, Sumner and Edgewood Water District

These cities or water utilities withdraw groundwater or springs that may affect the White River; however, tribal input is limited at this time due to time constraints.

Boise Creek

City of Enumclaw

The City of Enumclaw has Qi water rights for Boise Springs of 1.3 mgd or 2.0 cfs (City of Enumclaw 1993 Comprehensive Water System Plan, 1994). Boise Creek is utilized by spring chinook and suffers from low flow problems. Summer flows can be as low as 2 to 4 cfs.

Puyallup River

Lakehaven Utility District
City of Puyallup
City of Tacoma - wells
Summit

These cities or water utilities withdraw groundwater that may affect the Puyallup River; however, tribal input is limited at this time due to time constraints. Please note that the Muckleshoot Tribe shares treaty rights with the Puyallup Tribe in the Puyallup River watershed.

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WRIA 8		
Cedar-Sammamish-Lake Washington		
System	**Problems**	**Water Utilities**
Ballard Locks	Low Flow	Combined impacts of all in basin
& Ship Canal	Passage (smolt slides will be turned off too early)	
	Temperature/DO	
	Predation	
	Constricted estuary	
Sammamish River	Low Flow	City of Redmond - wells
	Low attraction flows - delays	(Utilities listed under Bear Creek also
	Temperature	affect the Sammamish River)
	Passage over the weir & harassment (adults)	
	Passage problem just below the weir	
Lake Sammamish	Temperature/DO	Sammamish Plateau
	Predation	City of Issaquah
Cedar River	Low Flow	City of Seattle - surface water
	Predation (exacerbated by low flows)	City of Renton - groundwater
		City of Kent - via Rock Cr.
Bear Creek	Low Flow	City of Redmond - wells
& Cottage Lake Cr.	Predation (exacerbated by low flows)	Northeast Sammamish Water and Sewer District - wells
	Low attraction flow - delay	Union Hill Water Association - wells
	Toxicity problems with road runoff in fall -	Cross Valley Water District - wells
	not utility related	
Issaquah Creek &	Low Flow	City of Issaquah
E. Fork Issaquah	Passage	Sammamish Plateau
	Predation (exacerbated by low flows)	
Rock Creek	Low Flow	City of Kent

WRIA 9		
Green-Duwamish River		
System	**Problems**	**Water Utilities**
Green-Duwamish	Low Flow	City of Tacoma - surface water & wells
	Temperature	City of Auburn - wells
		City of Black Diamond - springs
		(utilities w/ wells in Soos Creek basin also affect the Green)
Big Soos Creek	Low Flow	Covington Water District - wells
& Jenkins Cr.		City of Kent - wells
		WD #111
		Soos Creek WSD (most water from SPU, at least 1 well ?)
Newaukum Creek	Low Flow	City of Enumclaw
WRIA10		
White-Puyallup River		
System	**Problems**	**Water Utilities**
White River	Low Flow	City of Auburn - wells
	Temperature	City of Pacific - wells
	DO	City of Algona - wells ?
	Nutrients	City of Edgewood - wells ?
		City of Sumner - springs
Boise Creek	Low Flow	City of Enumclaw - springs
Puyallup River	Low Flow	City of Tacoma - wells
	DO	City of Fife?
	Nutrients	Milton?

		Lakehaven UD (Hylebos)

WRIA 8			
Cedar-Sammamish-Lake Washington			
System	**Water Utilities**	**Tools ***	
Ballard Locks	Combined effects of all in basin	Curtailment	
& Ship Canal		Flow Attraction	
		USCOE operations	
		need *for adequate inflow from*	
		from Cedar and Sammamish rivers	
		to keep smolt slides in operation	
		need *mitigation of problems in Ship Canal*	
		may need *estuary emergency lowering of lake*	
Sammamish River	City of Redmond - wells	Curtailment	
	(Utilities listed under Bear Creek also	Source diversion	
	affect the Sammamish River)	Postpone putting Redmond's replacement	
		well on-line	
		Limit access to weir	
Cedar River	City of Seattle - surface water	Curtailment	
	City of Renton - groundwater	Flow Attraction	
Bear Creek	City of Redmond - wells	Curtailment	
& Cottage Lake Cr.	Northeast Sammamish Water and Sewer District - wells	Source diversion	
	Union Hill Water Association - wells		
	Cross Valley Water District - wells		
Issaquah Creek &	City of Issaquah	Curtailment	
E. Fork Issaquah	Sammamish Plateau	Source diversion	
		Flow aggregation on East Fork (mouth, Front St.)	
Rock Creek	City of Kent	Curtailment	
		Source diversion	

WRIA 9			
Green-Duwamish River			
System	**Water Utilities**	**Tools ***	
Green-Duwamish	City of Tacoma - surface water & wells	Curtailment	
	City of Auburn - wells	Source diversion	
	City of Black Diamond - springs	Tacoma- flow attraction, augmentation?	
	(utilities in Soos Creek basin also affect the Green)		
Big Soos Creek	Covington Water District - wells	Curtailment	
& Jenkins Cr.	City of Kent - wells	Source diversion	
	WD #111		
	Soos Creek WSD (most water from SPU, at least 1 well ?)		
Newaukum Creek	City of Enumclaw	Curtailment	
		Source diversion	
		Flow aggregation at mouth	
WRIA10			
White-Puyallup River			
System	**Water Utilities**	**Tools ***	
White River	City of Auburn - springs & wells	Curtailment	
	City of Pacific - wells	Source diversion	
	City of Algona - wells ?		
	City of Edgewood - wells ?		
	City of Sumner - springs		
	City of Buckley - wells		
	City of Bonney Lake - wells ?		
Boise Creek	City of Enumclaw - springs	Curtailment	
		Source diversion	
* Flow augmentation is generally not an effective tool for these systems due to the nature of the hydrogeologic system with leaky aquifers.			
and timing of groundwater extraction on streamflow - see text.			