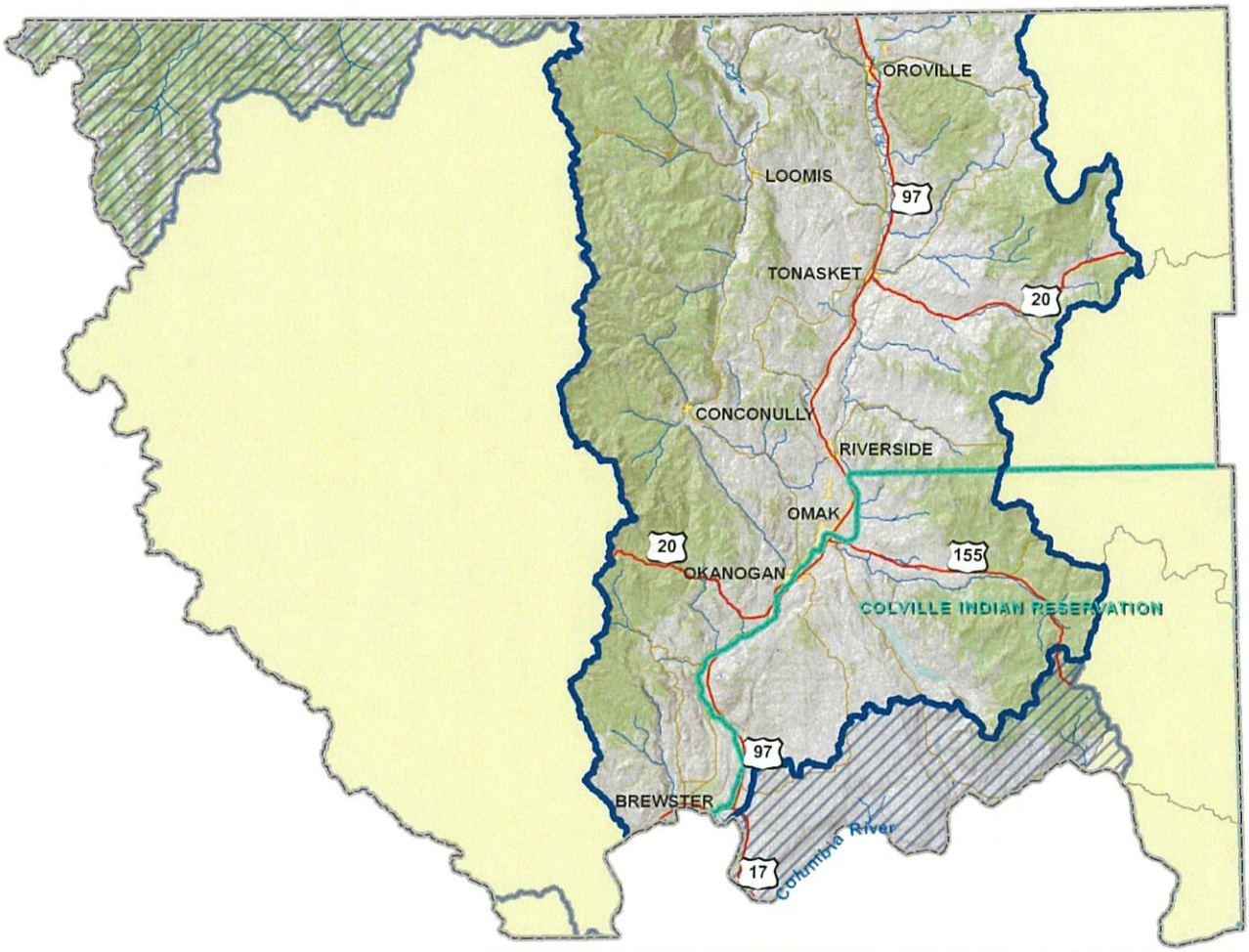
OKANOGAN WATERSHED PLAN

ENTRIX Water Balance



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Water Balance (revised from ENTRIX Level 1 Technical Report[1])

Water balance refers to the balance between the income of water from precipitation (rain and snow) and the outflow of water by evaporation, groundwater recharge, and streamflow.

The water balance was computed for each major subbasin using the following equation initially:

$$P - ET \pm \Delta GS - MAF = 0$$

Where: P is the average annual precipitation,
ET is the average annual evapotranspiration (portion of the precipitation returned to the air through direct evaporation and by transpiration of plants)
Δ *GS* is the change in groundwater storage
MAF is the mean annual flow

Over a long-term it was believed there would be a net interaction both from recharge from groundwater and seepage from the stream to groundwater. But it was found there was no change in the depth of the water table; therefore the change in groundwater storage (Δ*GS)* was estimated to be zero. Also, the variable evapotranspiration is difficult to measure and is evaluated as a potential; therefore *P* and *MAF* are known values and *ET* is the unknown value and the water balance equation was re-arranged. The final water balance computation became:

$$ET = P - MAF$$

A water balance was computed on a broader HUC 5 primary subbasin level for the WRIA 49 Watershed Assessment Level 1 Report (Sinlahekin, Osoyoos, Salmon, Omak, and Joseph) but for the Watershed Plan the Planning Unit desired a water balance for each individual HUC 6 drainage basin. There are 33 smaller individual drainage basins that either discharge directly into the Okanogan River or discharge into a major stream that drains to the Okanogan or Columbia Rivers. The data used to calculate the individual drainage basins were obtained from the Water Balance worksheet from Appendix D of the WRIA 49 Watershed Assessment Level 1 Report

[1] Okanogan Conservation District staff worked with ENTRIX to expand upon the water budget that was included in the Level 1 technical report. Water balances were calculated for each of the geographically distinct subwatersheds as per the request of the Okanogan Watershed Planning Unit.

Table 1. WRIA 49 Computed Mean Annual Precipitations per Drainage Basin

Primary Subbasin	Drainage Basin	MAP (in)	Primary Subbasin	Drainage Basin	MAP (in)
Sinlahekin	Sinlahekin Creek	21.00	Omak	Loup Loup Creek (Summit Creek)	16.00
Sinlahekin	Similkameen River	20.00	Omak	Tallant Creek	13.00
Sinlahekin	Toats Coulee Creek	25.00	Omak	Salmon Creek	20.00
Sinlahekin	Chopaka Lake	18.00	Omak	Johnson/Scotch Creek	13.00
Osoyoos	Nine Mile Creek	15.00	Omak	Pine Creek/Wa on Road Coulee	14.00
Osoyoos	Tonasket Creek	16.00	Omak	Duck Lake	12.00
Osoyoos	Antoine/Whiskey Cache Creek	15.00	Omak	Okanogan River - Middle	12.00
Osoyoos	Siwash Creek	16.00	Salmon	Tunk Creek	15.00
Osoyoos	Bonaparte Creek	17.00	Salmon	Wanacut Creek (CIR)*	15.00
Osoyoos	Chewilken Creek	15.00	Salmon	Omak Creek (CIR)*	14.50
Osoyoos	Okanogan River - Upper	12.00	Salmon	Omak Lake (CIR)*	12.00
Osoyoos	Horse Springs Coulee	15.00	Joseph	Chiliwist Creek	15.00
Osoyoos	Mosquito Creek	13.00	Joseph	Whitestone (Swamp) Creek	16.50
Osoyoos	Whitestone Lake	13.00	Joseph	Indian Dan Canon	14.00
Osoyoos	Whitestone Coulee	12.00	Joseph	Okanogan River - Lower	13.00
Osoyoos	Aeneas Creek	14.00	Joseph	Starzman Lake	13.00
Osoyoos	Baker Creek	20.00			

The precipitation data indicate that the Sinlahekin Creek, Toats Coulee Creek, Similkameen River, Baker Creek, and Salmon Creek receive significantly more water than the other drainage basins. Water balances were computed for each drainage basin using these precipitation values from map data and following methods and assumptions described earlier in the section. The results are summarized in Table 2. Detailed calculations are provided in a water balance spreadsheet. It was determined that there was too high ground water recharge in certain drainage basins. Since this is physically impossible to recharge more water into the ground than combined snow/rain amount; therefore the rain/snow runoff is zero. Also the groundwater recharge values may not represent the real values from the drainage basins; therefore they were lowered to reflect the correct inputs from snow/rain. Water Balance example of a drainage basin from the table below:

Sinlahekin Creek: *ET = P – MAF (116,388 = 142,464 – 26076)*

Table 2: Drainage Basin Water Balances (values in ac-ft per year)

Water Balances- values in ac-ft per year						
Drainage Basin	**Precipitation**	**ET**	**Recharge**	**(MAF)**	**MAF/Groundwater Discharge**	**MAF/Rain & Snow Runoff**
Sinlahekin Creek	142,464	116,388	7123	26076	7123	18953
Similkameen River	98,027	83,323	4901	14704	4901	9803
Toats Coulee Creek	179,467	145,413	8973	34054	8973	25081
Chopaka Lake	16,128	13,440	806	2688	806	1882
Nine Mile Creek	11,840	11,766	74	74	74	0
Tonasket Creek	51,456	49,116	1286	2340	1286	1054
Antoine/Whiskey Cache Creek	60,640	58,139	1516	2501	1516	985
Siwash Creek	38,059	36,989	951	1070	951	119
Bonaparte Creek	132,736	128,578	3318	4158	3318	840
Chewilken Creek	21,360	20,773	534	587	534	53
Okanogan River - Upper	10,560	10,477	83	83	83	0
Horse Springs Coulee	30,960	30,766	194	194	194	0
Mosquito Creek	5200	5162	38	38	38	0
Whitestone Lake	37,925	35,879	948	2046	948	1098
Whitestone Coulee	7360	7302	58	58	58	0
Aeneas Creek	6421	6120	161	301	161	140
Baker Creek	7467	7362	105	105	105	0
Loup Loup Creek (Summit Creek)	53,333	52,177	1156	1156	1156	0
Tallant Creek	8875	8803	72	72	72	0
Salmon Creek	178,560	148,595	4464	29965	4464	25501
Johnson/Scotch Creek	53,733	49,804	1343	3929	1343	2586
Pine Creek/Wa on Road Coulee	51,893	51,545	348	348	348	0
Duck Lake	3392	3365	27	27	27	0
Okanogan River - Middle	52,480	51,250	1230	1230	1230	0
Tunk Creek	56,800	54,528	2272	2272	2272	0
Wanacut Creek (CIR)*	15,200	14,687	513	513	513	0
Omak Creek (CIR)*	103,008	94,164	5150	8844	5150	3694
Omak Lake (CIR)*	147,136	145,986	1150	1150	1150	0
Chiliwist Creek	32,640	31,555	490	1085	490	595
Whitestone (Swamp) Creek	50,160	48,735	752	1425	752	673
Indian Dan Canon	12,768	12,511	192	257	192	65
Okanogan River - Lower	107,605	106,829	776	776	776	0
Starzman Lake	12,064	11,977	87	87	87	0

The calculations from the table below indicate that depending on the drainage basin, 81 percent to 99 percent of precipitation is returned to the atmosphere via evapotranspiration. With the lower evapotranspiration rates indicating more water is

available to recharge groundwater and support higher streamflows (per unit area). Therefore, mean annual stream flow (GrΔ + R) is significantly higher in the Sinlahekin Creek, Similkameen River, Toats Coulee Creek, and Salmon Creek.

Throughout the Okanogan Watershed, the availability of groundwater is limited to unconsolidated sediments of the major stream valleys. It was found that the groundwater recharge values may not represent real values; they were lowered to reflect the correct inputs from snow/rain. Groundwater recharge is roughly estimated to range from a low of .63 percent of precipitation in the Nine Mile Creek and Horse Springs Coulee to a high of 5 percent of precipitation in the Tunk Creek and Sinlahekin Creek drainages.

Similarly, the percentage of runoff as precipitation is roughly estimated to range from zero percent in several drainages to a high of 14.25 percent in the Salmon Creek.

Table 3. Percentage of Precipitation

	Percentage of Precipitation			
Drainage Basin	AS ET	AS Recharge (GR)	As Groundwater Discharge (Gd)	AS Runoff (R)
Sinlahekin Creek	81.70%	5.00%	5.00%	13.30%
Similkameen River	85.00%	5.00%	5.00%	10.00%
Toats Coulee Creek	81.02%	5.00%	5.00%	13.98%
Chopaka Lake	83.33%	5.00%	5.00%	11.67%
Nine Mile Creek	99.38%	0.63%	2.50%	0.00%
Tonasket Creek	95.45%	2.50%	2.50%	2.05%
Antoine/Whiskey Cache Creek	95.88%	2.50%	2.50%	1.62%
Siwash Creek	97.19%	2.50%	2.50%	0.31%
Bonaparte Creek	96.87%	2.50%	2.50%	0.63%
Chewilken Creek	97.25%	2.50%	2.50%	0.25%
Okanogan River - Upper	99.21%	0.79%	2.50%	0.00%
Horse Springs Coulee	99.37%	0.63%	2.50%	0.00%
Mosquito Creek	99.27%	0.73%	2.50%	0.00%
Whitestone Lake	94.61%	2.50%	2.50%	2.89%
Whitestone Coulee	99.21%	0.79%	2.50%	0.00%
Aeneas Creek	95.31%	2.50%	2.50%	2.19%
Baker Creek	98.59%	1.41%	2.50%	0.00%
Loup Loup Creek (Summit Creek)	97.83%	2.17%	2.50%	0.00%
Tallant Creek	99.19%	0.81%	2.50%	0.00%
Salmon Creek	83.22%	2.50%	2.50%	14.28%
Johnson/Scotch Creek	92.69%	2.50%	2.50%	4.81%
Pine Creek/Wa on Road Coulee	99.33%	0.67%	2.50%	0.00%
Duck Lake	99.20%	0.80%	2.50%	0.00%
Okanogan River - Middle	97.66%	2.34%	2.50%	0.00%
Tunk Creek	96.00%	4.00%	5.00%	0.00%
Wanacut Creek (CIR)*	96.63%	3.38%	5.00%	0.00%
Omak Creek (CIR)*	91.41%	5.00%	5.00%	3.59%
Omak Lake (CIR)*	99.22%	0.78%	5.00%	0.00%
Chiliwist Creek	96.68%	1.50%	1.50%	1.82%

Table 3. Percentage of Precipitation (continued)

	Percentage of Precipitation			
Drainage Basin	**AS ET**	**AS Recharge (GR)**	**As Groundwater Discharge (Gd)**	**AS Runoff (R)**
Whitestone (Swamp) Creek	97.16%	1.50%	1.50%	1.34%
Indian Dan Canon	97.99%	1.50%	1.50%	0.51%
Okanogan River - Lower	99.28%	0.72%	1.50%	0.00%
Starzman Lake	99.28%	0.72%	1.50%	0.00%

A water balance for the Okanogan River was developed using the measured mean annual flow (MAF) from the three USGS stations on the river and comparing these measured flows to the total surface water available. Table 4 indicates that the measured mean annual flow of the Okanogan River at Tonasket was 49,000 af/yr less than the total calculated total surface water available. The loss may be due to well extraction from the valley aquifer and water diversions from tributary streams and the Okanogan River. This net loss is reduced to about 21,000 ac-ft/yr at Malott, where return flow from tributary streams, diversions, and groundwater discharge have possibly made up some of the deficit.

Table 4. Okanogan River Water Balance

Okanogan River Water Balance					
	Tributary Basins		Okanogan River		
Major River/Subbasin	Calculated Total Surface Water Available	Measured Total Surface Water Available	Calculated Total Surface Water Available	Measured Total Surface Water Available	Net Loss/Gain
	AF/Y	AF/Y	AF/Y	AF/Y	AF/Y
Okanogan River at Oroville				494808	
Similkameen River from Canada	1594538				
Contribution from Sinlahekin Subbasin	77522				
Similkameen River (at Nighthawk)		1672060	2166868		
Contribution from Osoyoos Subbasin	13553				
Okanogan River at Tonasket			2180422	2131370	-49052
Contribution from Omak Subbasin	12779				
Contribution from Salmon Subbasin*	36726				
Okanogan River at Malott			2229926	2209092	-20834
Contribution from Joseph Subbasin	3630				
Okanogan River at Columbia River			2233556		

* includes portion referred to as Okanogan River - Middle