Appendix C. Results from Quality Control Analysis for Discrete Water-Quality Sampling in the Yakima River, Washington, 2004–07

Fourteen field equipment blank samples were analyzed for total and dissolved nutrients, including nitrogen (dissolved nitrite plus nitrate, dissolved ammonia, and total Kjeldahl nitrogen), phosphorus (SRP and total phosphorus), Chl *a*, and suspended sediment. Detections for nutrients in blank samples were sporadic and did not reveal any systemic sampling or laboratory contamination. Maximum concentrations in blank samples ranged from 0.01 to 0.02 mg/L for dissolved nitrate-plus-nitrite and dissolved ammonia, whereas one TKN sample contained 0.08 mg/L (table C1). TP and SRP were not detected in any blank samples.

The mean percent relative difference between split replicate nutrient samples ranged from 4 percent for SRP to 11 percent for dissolved ammonia (table C2). High variability in a few samples could have been due to errors during field processing (incomplete homogenizing or uneven use of pipettes) or laboratory processing (incomplete grinding of samples) or analysis.

The reproducibility of periphyton biomass values was somewhat elevated, especially for phaeophytin *a* and ash-free dry mass (table C3). The percent relative difference between replicate samples (not including split samples) ranged from about 17 percent for Chl *a* to 38 percent for phaeophytin *a*.

The reproducibility for triplicate algal biomass samples (splits) was within method tolerances, with percent differences of 8.5 percent and 4.5 percent for Chl *a* and ash-free dry mass, respectively. Greater variation in the phaeophytin *a* reproducibility, however, was observed (table C4).

The percent relative differences in nutrient content (as a percentage of total biomass) for the one replicate macrophyte sample were 8.6 percent and 4.3 percent for total nitrogen and total phosphorus, respectively (table C5).

Table C1. Quality-control results for nutrients, chlorophyll *a*, and suspended sediment in field blank samples, lower Yakima River Basin, Washington, 2004–07.

[All concentrations in milligrams per liter. Values in bold indicate detections. **Abbreviations:** RM, river mile; EWI, equal width and depth integrated sample; N, nitrogen; P, phosphorus; NO_3+NO_2-N, nitrate-plus-nitrite-N; NH_4, ammonium-N; TKN, total Kjeldahl nitrogen; SRP, soluble reactive phosphorus; TP, total phosphorus; TOC, total organic carbon; Chl *a*, chlorophyll *a*; SS, suspended sediment; <, less than; –, no data]

USGS site identification No.	Sampling location	RM	Method	Date	NO_3 + NO_2	NH_4	TKN	SRP	TP	TOC	Chl *a*	SS
12505320	Yakima River at RM 91 at Zillah	91.2	EWI	07-27-04	**0.01**	**0.01**	**0.08**	<0.003	<0.01	–	–	<1.0
12508850	Sulphur Creek Wasteway near Sunnyside	61.0	EWI	07-28-04	<0.01	<0.01	<0.03	<0.003	<0.01	–	–	**1**
12509710	Spring Creek at mouth near Whitstran	41.8	EWI	07-28-04	<0.01	<0.01	<0.03	<0.003	<0.01	–	–	**1**
12509060	Yakima River at Mabton Siphon near Grandview	53.0	Grab	03-31-05	–	–	–	–	–	–	<0.0005	–
12509060	Yakima River at Mabton Siphon near Grandview	53.0	Grab	05-25-05	–	–	–	–	–	–	**0.0009**	–
1250532120	Yakima River at RM 90.9 near Zillah	90.9	Grab	06-28-05	<0.01	<0.01	<0.03	<0.003	<0.01		–	–
12505330	Yakima River above E. Toppenish Drain near Granger	86.5	Grab	07-19-05	**0.01**	<0.01	<0.03	<0.003	<0.01	<0.2	–	–
12510400	Yakima River at RM 31.3 above Benton City	31.3	EWI	07-27-05	<0.01	<0.01	<0.03	<0.003	<0.01	**0.2**	–	–
12505325	Yakima River at RM 88.1 near Toppenish	88.0	EWI	08-17-05	<0.01	**0.02**	<0.03	<0.003	<0.01	**0.3**	–	–
12505050	Yakima River near Wapato, WA	102.7	Grab	03-29-06	**0.01**	<0.01	<0.03	<0.003	<0.01	–	–	–
12505040	Yakima River at RM 103 near Wapato	103.0	Grab	08-09-06	<0.01	**0.01**	<0.03	<0.003	<0.01	–	–	–
12505330	Yakima River above E. Toppenish Drain near Granger	86.5	Grab	10-03-06	<0.01	<0.01	<0.03	<0.003	<0.01			–
12505040	Yakima River at RM 103 near Wapato	103.0	Grab	07-31-07	<0.01	<0.01	<0.03	<0.003	<0.01	–	–	–

Table C2. Quality-control results for nutrient and suspended-sediment concentrations in split and replicate samples, lower Yakima River basin, Washington, 2004–07.

[Split samples were collected by subsampling from a depth-and-width integrated sample composited in a churn splitter. Replicate samples were discrete grab samples collected separately, but concurrently. All concentrations are in milligrams per liter. **Abbreviations:** Rep, replicate; RM, river mile; NO_3+NO_2-N, nitrate plus nitrite N; NH_4, dissolved ammonia; TKN, total Kjeldahl nitrogen; SRP, soluble reactive phosphorus; TP, total phosphorus; TOC, total organic carbon; USGS, U.S. Geological Survey; nc, not calculated; <, less than; –, no data]

USGS site identificaiton No.	Site name	Sample type	RM	Date	Nutrient concentration							Percent relative difference from the mean between replicates						
					NO_3 + NO_2-N	NH_4	TKN	SRP	TP	TOC	SS	NO_3 + NO_2-N	NH_4	TKN	SRP	TP	TOC	SS
12499000	Naches River near North Yakima	Split 1	115.9	07-26-04	0.08	< 0.01	0.17	0.008	0.023	–	3.0	0.0	0.0	26.7	0.0	8.3	–	0.0
		Split 2	115.9	07-26-04	0.08	< 0.01	0.13	0.008	0.025	–	3.0	–	–	–	–	–	–	–
12505350	East Toppenish Drain at Wilson Road near Toppenish	Split 1	86.0	07-27-04	1.94	0.04	0.20	0.109	0.148	–	10.0	1.0	22.2	4.9	0.0	0.0	–	0.0
		Split 2	86.0	07-27-04	1.96	0.05	0.21	0.109	0.148	–	10.0	–	–	–	–	–	–	–
12505440	Yakima River at Bridge Avenue at Granger	Split 1	83.0	07-27-04	0.13	0.01	0.20	0.024	0.050	–	6.0	4	0.0	5.3	0.0	1.0	–	9.1
		Split 2	83.0	07-27-04	0.12	0.01	0.18	0.024	0.049	–	5.0	–	–	–	–	–	–	–
12508680	Yakima River above Sulphur Creek at RM 61.3 near Mabton	Split 1	61.3	07-28-04	0.90	0.03	0.41	0.071	0.160	–	53.0	1.1	0.0	2.4	1.4	2.5	–	1.9
		Split 2	61.3	07-28-04	0.91	0.03	0.42	0.072	0.164	–	51.0	–	–	–	–	–	–	–
12510950	Yakima River at Horn Rapids Park	Split 1	19.0	06-29-05	0.71	< 0.01	0.26	0.091	0.111	–	–	1.4	nc	0.0	1.1	0.9	–	–
		Split 2	19.0	06-29-05	0.70	0.01	0.26	0.090	0.110	–	–	–	–	–	–	–	–	–
12505330	Yakima River above East Toppenish Drain near Granger	Split 1	86.2	07-19-05	0.08	0.02	0.20	0.022	0.043	2.2	–	0.0	0.0	0.0	4.7	4.5	0.0	
		Split 2	86.2	07-19-05	0.08	0.02	0.20	0.021	0.045	2.2	–	–	–	–	–	–	–	–
12505330	Yakima River above East Toppenish Drain near Granger	Split 1	86.2	07-20-05	0.10	0.02	0.25	0.020	0.043	2.2	–	18.2	0.0	0.0	9.5	11.0	9.5	4.8
		Split 2	86.2	07-20-05	0.12	0.02	0.25	0.022	0.048	2.0	–	–	–	–	–	–	–	–
12510500	Yakima River at Kiona	Split 1	29.9	07-27-05	0.66	< 0.01	0.24	0.132	0.163	2.7	–	0.0	nc	4.3	0.8	1.2	0.0	0.0
		Split 2	29.9	07-27-05	0.66	0.01	0.23	0.133	0.161	2.7	–	–	–	–	–	–	–	–
12510500	Yakima River at Kiona	Split 1	29.9	08-23-05	0.70	0.02	0.23	0.131	0.157	2.5	–	0.0	66.7	4.4	0.0	1.3	0.0	0.0
		Split 2	29.9	08-23-05	0.70	0.01	0.22	0.131	0.159	2.5	–	–	–	–	–	–	–	–
1250532400	Yakima River 3 feet from river bank at RM 89 near Zillah	Rep 1	89	07-12-06	0.02	< 0.01	0.23	0.012	0.034	–	–	0.0	0.0	19.0	8.7	26.7	–	–
		Rep 2	89	07-12-06	0.02	< 0.01	0.19	0.011	0.026	–	–	–	–	–	–	–	–	–
1250532170	Yakima River at RM 90.6 near Zillah	Rep 1	89	07-12-06	0.66	< 0.01	0.30	0.033	0.570	–	–	1.5	0.0	55.3	6.3	40.0	–	–
		Rep 2	89	07-12-06	0.67	< 0.01	0.17	0.031	0.380	–	–	–	–	–	–	–	–	–
12505325	Yakima River at RM 88.1 near Toppenish	Rep 1	88	07-27-06	0.13	0.05	0.20	0.030	0.057	–	–	0.0	22.2	4.9	3.4	5.4	–	–
		Rep 2	88	07-27-06	0.13	0.04	0.21	0.029	0.054	–	–	–	–	–	–	–	–	–
12505310	Yakima River below Highway 22 near Toppenish	Rep 1	92	08-14-06	0.09	0.03	0.07	0.025	0.040	–	–	0.0	28.6	25.0	4.1	0.0	–	–
		Rep 2	92	08-14-06	0.09	0.04	0.09	0.024	0.040	–	–	–	–	–	–	–	–	–
12505040	Yakima River at RM 103 near Wapato	Rep 1	103	09-19-06	0.24	0.03	0.14	0.043	0.064	–	–	4.1	40.0	6.9	0.0	15.8	–	–
		Rep 2	103	09-19-06	0.25	0.02	0.15	0.043	0.075	–	–	–	–	–	–	–	–	–
12505040	Yakima River at RM 103 near Wapato	Rep 1	103	05-30-07	0.06	< 0.01	0.17	0.022	0.046	–	–	0.0	0.0	6.1	20.0	4.4	–	–
		Rep 2	103	05-30-07	0.06	< 0.01	0.16	0.018	0.044	–	–	–	–	–	–	–	–	–
12505330	Yakima River above East Toppenish Drain near Granger	Rep 1	86.2	07-31-07	0.14	0.02	0.18	0.028	0.047	–	–	0.0	0.0	5.4	0.0	13.9	–	–
		Rep 2	86.2	07-31-07	0.14	0.02	0.19	0.028	0.054	–	–	–	–	–	–	–	–	–
12498990	Naches River at 40th Avenue near Yakima	Rep 1	2.8	08-7-07	0.03	< 0.01	0.14	0.005	0.032	–	–	40.0	0.0	7.4	0.0	3.1	–	–
		Rep 2	2.8	08-7-07	0.02	< 0.01	0.13	0.005	0.033	–	–						–	–
12505330	Yakima River above East Toppenish Drain near Granger	Rep 1	86.5	08-23-07	0.06	< 0.01	0.21	0.017	0.044	–	–	18.2	0.0	10.0	12.5	20.0	–	–
		Rep 2	86.5	08-23-07	0.05	< 0.01	0.19	0.015	0.036	–	–	–	–	–	–	–	–	–
Average percent relative difference from the mean between split replicate samples												**5.0**	**11**	**10.4**	**4.0**	**8.9**	**2.4**	**2.3**
Maximum percent relative difference from the mean between split replicate samples												**40**	**67**	**55**	**20**	**40**	**9.5**	**9.1**

Table C3. Quality-control results for periphyton biomass and phytoplankton chlorophyll *a* in replicate and split samples, Yakima River, Washington, 2004–06.

[Split samples were collected by subsampling from a homogenized sample collected in a churn splitter. Replicate samples were discrete environmental samples collected separately, but concurrently.
Abbreviations: RM, river mile; USGS, U.S. Geological Survey; mg/m^2, milligram per square meter; mg/m^3; milligram per cubic meter; g/m^2, gram per square meter; –, not applicable]

USGS site identification No.	Site name	Sample	RM	Date	Periphyton biomass									Percent relative difference from the mean between replicates[1]		
					Chlorophyll *a* (mg/m^2)			Phaeophytin *a* (mg/m^2)			Ash-free dry mass (g/m^2)			Chlorophyll *a* (mg/m^2)	Phaeophytin *a* (mg/m^2)	Ash-free dry mass (g/m^2)
					Split 1	Split 2	Split 3	Split 1	Split 2	Split 3	Split 1	Split 2	Split 3			
12505060	Yakima River at RM 102.6 near Parker	[2]Rep 1	102.6	08-14-06	81	67	46	12	8	7	20	19	18	17	38	26
		[2]Rep 3	102.6	08-14-06	55	55	95	9	7	15	15	16	17			
		[2]Rep 3	102.6	08-14-06	58	57	45	7	6	5	15	15	14	–	–	–

USGS site identification No.	Site name	Sample	RM	Date	Phytoplankton biomass									Percent relative difference from the mean between replicates		
					Chlorophyll *a* (mg/m^3)			Phaeophytin *a* (mg/m^2)			Ash-free dry mass (g/m^2)			Chlorophyll *a* (mg/m^3)	Phaeophytin *a* (mg/m^2)	Ash-free dry mass (g/m^2)
					Split 1	Split 2	Split 3	Split 1	Split 2	Split 3	Split 1	Split 2	Split 3			
12508680	Yakima River above Sulphur Creek at RM 61.3 near Mabton	[3]Split 1	61.3	07-28-04	–	10.0	–	–	–	–	–	–	–	14.8	–	–
		[3]Split 2	61.3	07-28-04	–	11.6	–	–	–	–	–	–	–	–	–	–
12509060	Yakima River at Mabton Siphon near Grandview	[2]Rep 1	53.0	03-31-05	–	19.5	–	–	–	–	–	–	–	1.6	–	–
		[2]Rep 2	53.0	04-05-05	–	19.2	–	–	–	–	–	–	–	–	–	–
12509060	Yakima River at Mabton Siphon near Grandview	[2]Rep 1	53.0	05-25-05	–	12.9	–	–	–	–	–	–	–	4.5	–	–
		[2]Rep 2	53.0	05-25-05	–	13.5	–	–	–	–	–	–	–	–	–	–

[1]Calculated from averaging the three split samples.

[2]Grab sample.

[3]Depth-and-width integrated sample (EWI) collected in a churn splitter.

Table C4. Quality-control results for periphyton biomass for triplicate split samples in the Yakima River, Washington, 2006–07.

[Split samples were subsampled from a single composite sample. **Percent Difference:** average percent difference from the median. **Abbreviations:** RM, river mile; mg/m^2, milligrams per square meter; g/m^2, grams per square meter; –, no data]

USGS site identification No.	Sampling location	RM	Date	Chlorophyll *a* (mg/m^2)				Phaeophytin *a* (mg/m^2)				Ash-free dry mass (g/m^2)			
				Split 1	Split 2	Split 3	Percent difference	Split 1	Split 2	Split 3	Percent difference	Split 1	Split 2	Split 3	Percent difference
12505040	Yakima River at RM 103 near Wapato	103.0	08-14-06	65	67	68	1	19	18	20	4	23	22	21	3
12505060	Yakima River at RM 102.6 near Parker	102.6	08-14-06	95	55	55	24	15	9	7	30	17	15	16	4
12505060	Yakima River at RM 102.6 near Parker	102.6	08-14-06	46	81	67	17	7	12	8	21	18	20	19	4
12505060	Yakima River at RM 102.6 near Parker	102.6	08-14-06	45	58	57	8	6	7	5	11	15	15	14	2
12505310	Yakima River below Highway 22 near Toppenish	92.0	08-14-06	52	60	57	5	9	1	5	53	14	16	18	8
12505330	Yakima River above East Toppenish Drain near Granger	86.5	08-15-06	56	67	56	7	7	4	8	19	19	18		35
12505325	Yakima River at RM 88.1 near Toppenish	88.0	08-15-06	41	43	38	4	2	4	5	25	12	12	13	3
12505330	Yakima River above East Toppenish Drain near Granger	86.5	09-21-06	255	243	214	6	12	15	53	91	–	–	–	
12505040	Yakima River at RM 103 near Wapato	103.0	10-02-06	132	128	147	5	10	13	11	9	24	24	22	3
12505060	Yakima River at RM 102.6 near Parker	102.6	10-02-06	251	267	283	4	17	14	9	19	33	31	33	2
12505330	Yakima River ab East Toppenish Drain near Granger	86.5	10-03-06	143	186	168	9	20	27	38	22	36	29	30	8
12505325	Yakima River At RM 88.1 near Toppenish	88.0	10-03-06	146	179	155	7	21	27	31	12	35	31	31	4
12505310	Yakima River below Highway 22 near Toppenish	92.0	10-03-06	193	225	226	5	15	19	10	20	37	34	36	3
12505330	Yakima River above East Toppenish Drain near Granger	86.5	05-30-07	30	41	38	10	42	3	1	456	12	11	12	3
12505040	Yakima River at RM 103 near Wapato	103.0	05-30-07	66	67	56	6	11	1	9	37	16	20	15	10
12505040	Yakima River at RM 103 near Wapato	103.0	06-12-07	68	82	76	6	3	1	2	33	22	21	22	2
12505040	Yakima River at RM 103 near Wapato	103.0	07-16-07	26	27	31	6	9	6	7	14	20	19	22	5
12505040	Yakima River at RM 103 near Wapato	103.0	07-16-07	37	40	50	11	1	3	1	67	19	19	15	7
12505040	Yakima River at RM 103 near Wapato	103.0	07-16-07	67	79	90	10	5	7	9	19	18	17	18	2
12505270	Yakima River at RM 94.4 near Buena	95.0	07-16-07	39	66	37	25	4	1	2	50	15	16	14	4
12505330	Yakima River above East Toppenish Drain near Granger	86.5	07-17-07	35	29	27	9	1	2	3	33	16	13	15	7
12494450	Naches River at RM 12.2 near Naches	12.2	07-24-07	32	34	40	8	3	3	5	22	16	17	17	2
12498990	Naches River at 40th Avenue near Yakima	2.8	07-24-07	20	20	22	3	4	3	3	11	9	9	9	0
12505330	Yakima River above East Toppenish Drain near Granger	86.5	07-31-07	30	31	25	7	1	1	3	67	21	20	20	2
12505040	Yakima River at RM 103 near Wapato	103.0	07-31-07	89	73	91	7	9	7	9	7	25	26	24	3
12505040	Yakima River at RM 103 near Wapato	103.0	07-31-07	40	33	40	6	3	3	2	11	17	16	18	4
12505040	Yakima River at RM 103 near Wapato	103.0	07-31-07	102	51	54	31	11	5	1	67	28	33	34	6
12505270	Yakima River at RM 94.4 near Buena	95.0	07-31-07	39	57	37	17	2	2	4	33	24	25	25	1
12505270	Yakima River at RM 94.4 near Buena	95.0	07-31-07	21	24	19	8	3	1	2	33	17	16	17	2
12494450	Naches River at RM 12.2 near Naches	12.2	08-07-07	78	70	68	5	5	4	6	13	28	23	21	10
12498990	Naches River at 40th Avenue near Yakima	2.8	08-07-07	43	46	47	3	5	5	3	13	15	14	15	2
12510500	Yakima River at Kiona	29.9	08-07-07	12	8	8	17	1	1	1	0	2	2	2	0
12498690	Naches River above Diversion Dam near Yakima	3.5	08-23-07	41	35	42	6	9	6	6	17	15	15	15	0
12505330	Yakima River above East Toppenish Drain near Granger	86.5	08-23-07	29	34	34	5	7	6	7	5	11	10	11	3
12505040	Yakima River at RM 103 Near Wapato	103.0	08-23-07	46	51	54	5	10	7	10	10	11	12	13	6
12498690	Naches River above Diversion Dam near Yakima	3.5	09-03-07	47	56	49	6	3	4	4	8	13	14	12	5
12505330	Yakima River above East Toppenish Drain near Granger	86.5	09-03-07	78	77	75	1	4	6	6	11	15	16	16	2
12505040	Yakima River at RM 103 near Wapato	103.0	09-03-07	75	72	64	5	10	8	8	8	20	19	20	2
Average percent difference from the mean for all samples							**8.5**				**36**				**4.5**
Maximum percent difference from the mean for all samples							**31**				**456**				**35**

Table C5. Quality-control results for replicate nutrient content in macrophyte samples in the Yakima River at river mile 18, Washington, August 30, 2005.

[Replicate samples were collected independently. **Abbreviation:** Rep, replicate; –, no data]

Sample type	Macrophyte biomass (percent)		Percent relative difference from the mean between replicates	
	Total nitrogen	Total phosphorus	Total nitrogen	Total phosphorus
Rep 1	2.6	0.45	8.6	4.3
Rep 2	2.8	0.47	–	–