Appendix A. Relating Flow from Continuous Streamgage Stations to Water-Quality Stations for Burnt Bridge Creek at Vancouver Lake (14211920), Salmon Creek at Lake River (14213050), and Lake River at Felida (14211955)

Calculation of water and nutrient budgets for Vancouver Lake required knowledge of mean daily flow for several water-quality stations that did not correspond to locations with streamgages stations. In some cases, a flow correction was needed before the load estimation model (LOADEST) could be used to simulate nutrient loads. On Burnt Bridge Creek, the water-quality station (14211920) was located approximately 1.5 mi downstream of the continuous streamgage (14211902) (fig. 5). On this reach, the measured flow during water quality sampling was very similar to the flow at the upstream streamgage except for one high flow measurement (fig. A1). Because flow at Burnt Bridge Creek was rarely (less than 2 percent of the time) greater than 80 ft^3/s during the 2-year study, we assumed that flow downstream was equal to the upstream flow when simulating loads in Burnt Bridge Creek.

The water quality sampling location for Lake River at Felida was about 8 mi from the continuous streamgage at Ridgefield (Lake River at Ridgefield. Flow between these two locations was not the same and it was necessary to estimate the mean daily flow at Felida from data collected at Ridgefield. Between these two locations on Lake River, the only major input is flow from Salmon Creek (fig. 5). On Salmon Creek, there was a continuous-flow streamgage operated by Clark Public Utilities (Salmon Creek at Northcutt) upstream from the U.S. Geological Survey (USGS) water quality sampling location (Salmon Creek at Lake River) (fig. 5). Therefore, to recreate the continuous flow record for Lake River at Felida, flow data from Salmon Creek at Lake River was added to the flow from Lake River at Ridgefield when flow was into the lake. When flow on Lake River was away from the lake, flow from Salmon Creek at Lake River was subtracted from the flow at Lake River at Ridgefield. Creating the continuous flow record for Lake River at Felida took place in multiple steps.

1. Continuous flow at Salmon Creek at Lake River, where USGS only had data during the time of water quality sampling, had to be related to the 15-minute flow data upstream at Northcutt measured by Clark Public Utilities (fig. A2). Flow measured by USGS at Salmon Creek at Lake River was consistently greater than the data upstream at Northcutt. A curvilinear relationship between instantaneous flow downstream and upstream on Salmon Creek (R^2=0.92) was used to recreate 15-minute data at Salmon Creek at Lake River. These data were then used to estimate mean daily flow for Salmon Creek at Lake River for LOADEST (tables A1–A3).
2. Once 15-minute data for Salmon Creek at Lake River was calculated, these data were added to, or subtracted from data at the same time measured by USGS at Lake River at Ridgefield corresponding to when flow was leaving or entering the lake, respectively. This procedure allowed a direct comparison between flow measured at Felida during water quality sampling and flow at Ridgefield (fig. A2). A linear relationship between flow at these two locations (R^2=0.92) was used to estimate 15-minute data for Lake River at Felida.
3. The calculated 15-minute data for Lake River at Ridgefield was used to determine hourly mean flow that was split into two separate records one for negative flow (into the lake), and one for positive flow (out of the lake). This split record of mean hourly flow was used to estimate mean daily flow into and out of the lake for use in the water and nutrient budgets of the lake (tables A4–A9).

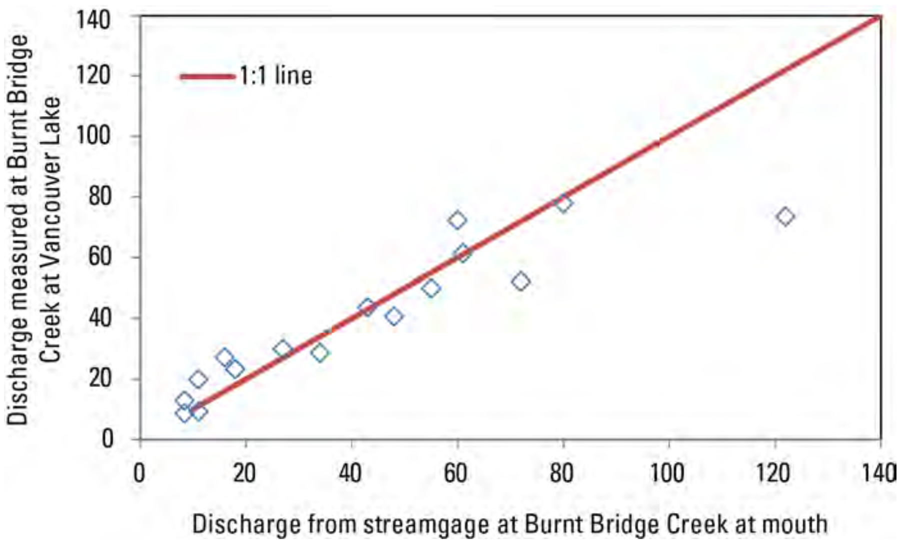

Figure A1. Graph showing relationship between measured discharge at Burnt Bridge Creek at Vancouver Lake and discharge at the continuous flow, upstream streamgage, Burnt Bridge Creek at mouth, Vancouver, Washington. (Discharge in cubic feet per second.)

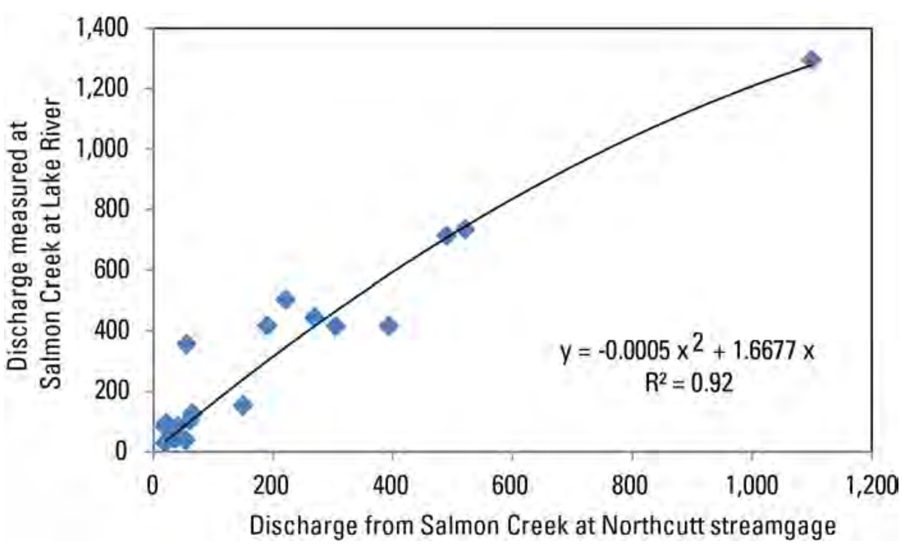

Figure A2. Graph showing relationship between measured discharge at Salmon Creek at Lake River and flow at the continuous discharge upstream streamgage at Northcutt operated by Clark Public Utilities, Vancouver, Washington. (Discharge in cubic feet per second.)

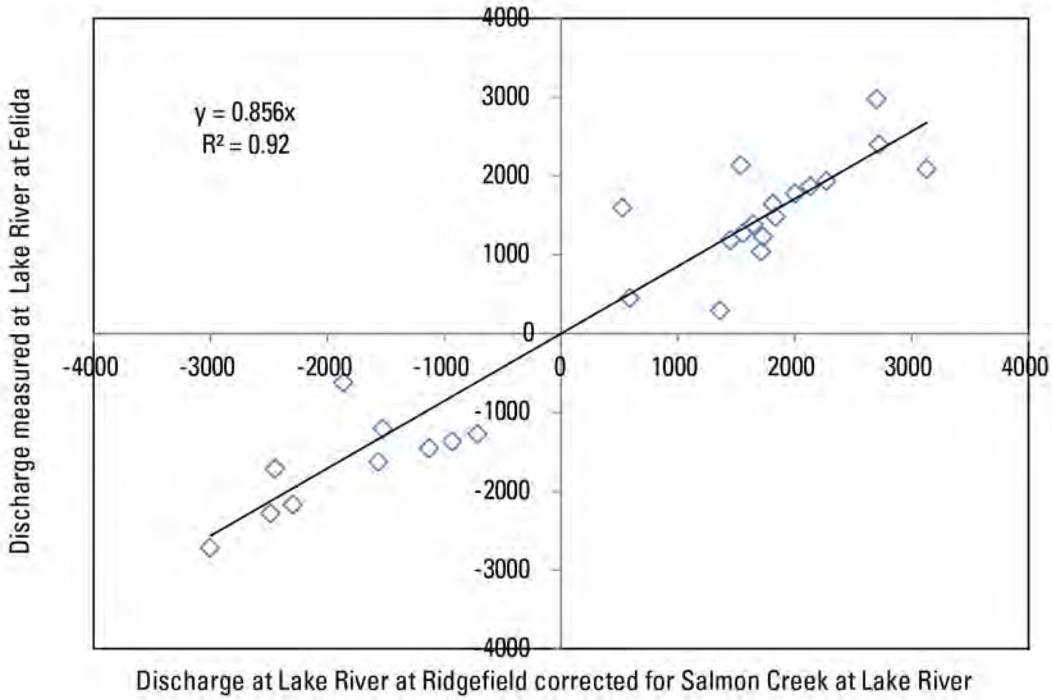

Figure A3. Graph showing relationship between discharge measured at Lake River at Felida and discharge at Lake River at Ridgefield after being corrected for discharge from Salmon Creek at Lake River, Vancouver, Washington. (Discharge in cubic feet per second.)

Table A1. Surface water estimated daily mean discharge at Salmon Creek and Lake River (14213050, Vancouver, Washington), water year 2011.

[Daily mean discharge, in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	38	233	582	473	187	1059	506	321	132	67	39	31
2	36	531	490	386	173	905	501	279	168	62	38	30
3	36	314	397	326	163	718	425	248	177	60	37	29
4	36	219	331	282	156	605	498	221	143	60	37	28
5	35	167	282	309	153	679	828	205	126	56	36	28
6	34	150	264	399	165	538	659	196	118	54	36	28
7	34	356	251	367	193	438	642	239	112	54	37	28
8	34	300	436	368	200	393	493	271	108	52	37	28
9	57	280	762	346	178	404	403	309	103	51	36	27
10	159	425	1078	314	167	878	381	264	96	50	39	27
11	137	335	919	283	161	701	426	248	96	48	39	27
12	84	280	1090	481	159	586	364	288	92	51	37	27
13	67	235	851	907	262	573	340	231	94	63	34	27
14	56	443	946	729	290	646	462	211	90	56	34	28
15	51	463	1003	664	498	600	794	451	86	53	34	30
16	47	477	751	1286	541	646	821	609	86	54	33	30
17	45	486	582	1225	511	596	614	426	81	80	33	34
18	43	1055	526	925	402	579	474	329	86	83	32	39
19	42	884	454	831	357	519	383	262	105	64	32	42
20	41	733	451	628	292	431	325	221	92	57	32	38
21	40	576	411	742	256	387	287	199	84	54	35	35
22	40	563	347	726	242	358	258	183	77	55	31	34
23	43	620	297	556	231	315	229	166	74	50	33	33
24	154	436	266	461	244	338	230	154	70	48	35	32
25	230	351	257	387	222	373	434	156	68	46	31	33
26	176	323	297	332	195	379	455	178	66	46	30	42
27	237	356	350	294	194	468	410	172	64	44	31	58
28	170	362	955	265	652	454	425	176	67	42	30	53
29	170	328	1194	244	---	527	482	153	71	41	29	39
30	141	437	823	223	---	787	383	144	74	40	31	35
31	202	---	603	209	---	635	---	136	---	41	-205	---

Table A2. Surface water estimated daily mean discharge at Salmon Creek and Lake River (14213050), Vancouver, Washington, water year 2012.

[Daily mean discharge, in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	33	67	258	467	419	582	836	296	127	139	45	33
2	34	61	226	361	342	518	694	335	120	117	47	33
3	43	144	197	295	296	530	607	506	110	123	44	31
4	50	98	175	257	258	509	627	552	117	120	43	31
5	59	81	157	271	227	501	833	445	338	103	42	31
6	62	73	144	239	205	491	728	359	297	93	42	30
7	56	62	134	257	189	396	560	296	300	86	42	30
8	60	58	126	233	179	339	444	248	292	81	41	29
9	52	55	119	213	193	295	367	212	316	77	42	28
10	58	51	112	233	192	277	316	183	249	74	40	30
11	72	51	109	201	196	404	311	167	200	72	39	32
12	69	67	105	182	175	468	378	154	176	69	39	30
13	56	105	100	168	185	1017	302	140	230	68	38	29
14	50	103	95	164	196	848	259	130	178	66	35	29
15	48	95	100	167	225	1188	226	119	152	63	38	29
16	45	104	102	153	212	1016	351	111	133	65	38	29
17	42	262	95	218	253	826	339	105	120	66	35	29
18	40	266	94	635	418	707	322	100	118	62	34	28
19	39	234	92	1113	389	603	325	96	116	62	35	28
20	39	182	90	1299	353	577	462	95	109	63	36	29
21	39	196	88	1061	495	717	385	131	99	62	36	31
22	40	674	84	783	914	814	324	153	97	57	35	31
23	41	1128	82	707	749	721	274	149	219	56	34	30
24	40	874	80	700	559	557	232	163	213	53	33	30
25	38	699	80	709	591	465	208	170	151	52	33	31
26	37	494	84	581	604	387	252	339	209	51	33	32
27	37	419	98	461	495	341	222	333	207	51	33	32
28	39	490	397	389	419	316	197	220	160	50	33	32
29	56	366	601	364	523	399	180	172	140	48	32	31
30	54	315	846	606	---	1017	278	144	125	48	33	30
31	83	---	650	508	---	923	---	131	---	49	33	---

Table A3. Surface water estimated daily mean discharge at Salmon Creek and Lake River (14213050), Vancouver, Washington, water year 2013.

[Daily mean discharge, in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	32	---	---	---	---	---	---	---	---	---	---	---
2	31	---	---	---	---	---	---	---	---	---	---	---
3	30	---	---	---	---	---	---	---	---	---	---	---
4	30	---	---	---	---	---	---	---	---	---	---	---
5	28	---	---	---	---	---	---	---	---	---	---	---
6	29	---	---	---	---	---	---	---	---	---	---	---
7	30	---	---	---	---	---	---	---	---	---	---	---
8	30	---	---	---	---	---	---	---	---	---	---	---
9	30	---	---	---	---	---	---	---	---	---	---	---
10	31	---	---	---	---	---	---	---	---	---	---	---
11	32	---	---	---	---	---	---	---	---	---	---	---
12	46	---	---	---	---	---	---	---	---	---	---	---
13	88	---	---	---	---	---	---	---	---	---	---	---
14	54	---	---	---	---	---	---	---	---	---	---	---
15	128	---	---	---	---	---	---	---	---	---	---	---
16	118	---	---	---	---	---	---	---	---	---	---	---
17	67	---	---	---	---	---	---	---	---	---	---	---
18	51	---	---	---	---	---	---	---	---	---	---	---
19	51	---	---	---	---	---	---	---	---	---	---	---
20	96	---	---	---	---	---	---	---	---	---	---	---
21	131	---	---	---	---	---	---	---	---	---	---	---
22	93	---	---	---	---	---	---	---	---	---	---	---
23	95	---	---	---	---	---	---	---	---	---	---	---
24	95	---	---	---	---	---	---	---	---	---	---	---
25	82	---	---	---	---	---	---	---	---	---	---	---
26	68	---	---	---	---	---	---	---	---	---	---	---
27	78	---	---	---	---	---	---	---	---	---	---	---
28	248	---	---	---	---	---	---	---	---	---	---	---
29	482	---	---	---	---	---	---	---	---	---	---	---
30	427	---	---	---	---	---	---	---	---	---	---	---
31	443	---	---	---	---	---	---	---	---	---	---	---

Table A4. Surface water estimated daily mean inflow discharge at Lake River at Felida (14211955), Washington, water year 2011.

[Daily mean discharge, in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	459	785	1355	329	449	527	4596	520	780	1091	1179	651
2	409	1042	1035	351	306	185	774	1051	587	1612	950	312
3	503	791	930	900	439	160	377	351	499	645	515	354
4	453	935	654	834	574	512	587	737	754	697	633	408
5	719	931	638	353	456	503	190	737	621	31	485	407
6	920	914	557	286	231	1030	46	390	545	228	453	374
7	1140	1118	722	439	360	715	1136	669	311	450	461	457
8	926	739	976	223	634	796	658	480	248	432	524	602
9	1078	707	913	385	577	662	438	767	262	545	586	727
10	923	483	782	376	419	939	197	719	372	509	526	655
11	305	239	259	266	452	803	559	665	512	552	837	696
12	406	19	773	1192	766	1059	820	330	481	701	956	662
13	345	104	590	1466	594	1163	334	1692	818	282	738	623
14	322	417	1205	716	757	1443	449	2271	766	582	505	519
15	171	483	1147	935	1677	628	77	2086	797	1338	668	535
16	255	754	596	3381	2034	962	599	3317	705	607	813	524
17	305	766	942	4908	1062	1784	781	2740	701	239	652	360
18	405	1213	1040	1413	991	1224	1202	1607	271	562	460	350
19	614	751	824	911	747	442	1242	967	6	585	547	344
20	708	953	952	203	534	154	1110	628	12	314	347	345
21	753	675	732	271	531	600	944	561	129	280	374	363
22	768	811	639	94	584	620	882	289	299	325	373	458
23	748	472	656	799	651	1350	1340	447	344	308	413	505
24	1199	289	404	642	783	530	879	606	981	392	603	765
25	1128	376	413	561	565	905	858	454	1221	470	879	931
26	635	732	1526	30	105	770	3437	560	86	447	749	994
27	396	487	1665	598	296	272	588	975	365	517	801	1053
28	439	311	672	626	355	384	919	891	396	637	937	780
29	314	306	551	465	---	857	466	991	403	639	791	727
30	373	842	1355	204	---	1217	140	958	780	944	893	708
31	427	---	1035	579	---	3817	---	809	---	802	844	---

Table A5. Surface water estimated daily mean inflow discharge at Lake River at Felida, Washington (14211955), water year 2012.

[Daily mean discharge, in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	478	213	72	350	402	185	774	95	702	1011	941	615
2	382	350	250	30	5	160	377	886	864	872	655	438
3	552	470	243	226	253	512	587	1050	793	577	750	332
4	409	408	336	568	418	503	190	1838	1369	407	757	414
5	565	467	447	622	518	1030	46	572	1308	908	759	558
6	385	534	545	394	623	715	1136	650	1190	787	544	584
7	407	482	554	403	832	796	658	438	1814	243	420	391
8	388	504	654	490	862	662	438	283	925	164	294	352
9	625	597	563	697	701	939	197	144	858	315	306	278
10	812	622	699	600	794	803	559	241	323	455	324	237
11	1016	799	713	616	746	1059	820	96	244	553	309	337
12	601	612	539	491	481	1163	334	149	234	428	571	473
13	427	708	553	498	529	1443	449	339	518	454	723	584
14	667	528	465	552	619	628	77	64	400	669	603	714
15	585	334	462	451	385	962	599	368	408	467	501	871
16	398	447	274	460	511	1784	781	1104	690	818	986	779
17	295	817	337	769	483	1224	1202	637	275	1018	857	706
18	310	494	450	1053	865	442	1242	1241	731	449	985	839
19	321	397	451	3200	499	154	1110	1338	922	416	689	794
20	273	458	548	3572	776	600	944	485	1509	604	793	518
21	370	735	616	2545	903	620	882	874	901	1333	738	361
22	604	1465	589	607	1644	1350	1340	452	464	1203	555	345
23	633	2490	734	193	1174	530	879	1137	885	389	575	292
24	561	937	801	395	482	905	858	876	477	437	492	337
25	702	541	1014	457	565	770	3437	543	1142	60	535	449
26	975	362	618	328	105	272	588	485	984	398	469	504
27	727	550	762	154	296	384	378	45	828	641	604	629
28	915	393	1354	195	355	857	259	4	999	475	844	712
29	818	269	1074	266	527	1217	149	104	333	530	688	791
30	489	177	2257	291	---	3817	774	293	706	772	874	426
31	241	---	281	424	---	4596	---	691	---	892	790	---

Table A6. Surface water estimated daily mean inflow discharge at Lake River at Felida, Washington (14211955), water year 2013.

[Daily mean discharge, in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	402	---	---	---	---	---	---	---	---	---	---	---
2	440	---	---	---	---	---	---	---	---	---	---	---
3	412	---	---	---	---	---	---	---	---	---	---	---
4	408	---	---	---	---	---	---	---	---	---	---	---
5	258	---	---	---	---	---	---	---	---	---	---	---
6	256	---	---	---	---	---	---	---	---	---	---	---
7	282	---	---	---	---	---	---	---	---	---	---	---
8	373	---	---	---	---	---	---	---	---	---	---	---
9	400	---	---	---	---	---	---	---	---	---	---	---
10	431	---	---	---	---	---	---	---	---	---	---	---
11	501	---	---	---	---	---	---	---	---	---	---	---
12	567	---	---	---	---	---	---	---	---	---	---	---
13	538	---	---	---	---	---	---	---	---	---	---	---
14	649	---	---	---	---	---	---	---	---	---	---	---
15	903	---	---	---	---	---	---	---	---	---	---	---
16	1048	---	---	---	---	---	---	---	---	---	---	---
17	599	---	---	---	---	---	---	---	---	---	---	---
18	557	---	---	---	---	---	---	---	---	---	---	---
19	539	---	---	---	---	---	---	---	---	---	---	---
20	476	---	---	---	---	---	---	---	---	---	---	---
21	443	---	---	---	---	---	---	---	---	---	---	---
22	464	---	---	---	---	---	---	---	---	---	---	---
23	403	---	---	---	---	---	---	---	---	---	---	---
24	425	---	---	---	---	---	---	---	---	---	---	---
25	458	---	---	---	---	---	---	---	---	---	---	---
26	636	---	---	---	---	---	---	---	---	---	---	---
27	808	---	---	---	---	---	---	---	---	---	---	---
28	791	---	---	---	---	---	---	---	---	---	---	---
29	1313	---	---	---	---	---	---	---	---	---	---	---
30	892	---	---	---	---	---	---	---	---	---	---	---
31	773	---	---	---	---	---	---	---	---	---	---	---

Table A7. Surface water estimated daily mean outflow discharge at Lake River at Felida, Washington (14211955), water year 2011.

[Daily mean discharge, in cubic feet per second (cfs)]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	518	502	341	1065	904	537	510	671	624	522	574	754
2	558	415	539	1316	1061	838	611	408	723	223	717	977
3	563	548	577	832	925	732	1297	940	977	790	983	984
4	628	558	754	723	809	369	2370	627	568	689	891	866
5	475	609	781	1052	884	445	1803	584	672	1986	1040	684
6	408	661	855	1191	947	343	750	976	585	1494	1136	618
7	442	555	680	813	833	505	1135	700	873	672	977	541
8	537	733	574	834	525	502	1858	863	817	867	608	521
9	510	741	522	681	521	616	2069	403	825	902	654	449
10	634	697	367	835	768	554	1281	397	779	1045	716	510
11	923	926	662	753	780	670	699	468	679	1179	546	543
12	879	889	399	315	414	611	1050	1153	865	1368	466	540
13	826	749	506	126	635	597	637	11	607	1354	684	566
14	595	539	5	473	667	282	1359	260	682	915	827	627
15	671	474	358	326	216	586	724	132	656	502	691	616
16	607	393	1276	12	241	256	516	435	782	1030	608	609
17	583	382	2001	196	751	63	341	722	763	1286	645	738
18	518	235	1143	658	825	353	352	901	1186	1019	733	715
19	406	416	711	1724	990	728	417	734	1662	735	623	681
20	418	464	724	2035	1111	1171	567	882	1766	1082	876	624
21	447	663	885	1744	1054	878	747	497	1274	1017	921	524
22	483	619	811	957	1099	742	333	408	634	1086	910	484
23	500	711	900	1095	942	336	534	375	653	1094	728	504
24	383	847	954	1368	1020	831	636	627	243	966	404	492
25	452	782	903	2000	1007	739	430	147	157	818	354	447
26	687	597	989	1223	913	586	720	358	1888	751	597	446
27	773	652	1067	935	674	1256	1288	312	1734	716	589	495
28	767	757	392	1102	654	1334	510	412	935	618	537	611
29	728	769	178	1480	---	737	611	556	878	831	698	664
30	683	534	824	1063	---	240	1297	671	1027	598	642	667
31	619	---	817	1065	---	294	---	408	---	726	691	---

Table A8. Surface water estimated daily mean outflow discharge at Lake River at Felida, Washington (14211955), water year 2012.

[Daily mean discharge, in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	735	787	864	926	919	838	294	934	739	511	623	684
2	879	549	775	1239	1219	732	510	298	768	851	871	768
3	625	498	757	1046	899	369	611	642	834	1269	779	769
4	629	570	656	499	676	445	1297	210	547	1643	796	719
5	496	568	530	526	629	343	2370	1288	577	916	748	602
6	658	521	373	787	584	505	1803	1112	652	708	847	495
7	682	529	419	746	528	502	750	1737	183	1086	869	741
8	585	534	385	753	550	616	1135	1943	615	1467	1093	801
9	494	487	475	542	661	554	1858	1862	425	1032	938	788
10	391	500	443	584	637	670	2069	1272	1059	967	943	554
11	398	448	475	555	650	611	1281	1245	1368	416	928	535
12	652	568	546	640	793	597	699	989	931	728	342	479
13	679	519	576	638	911	282	1050	1037	749	971	379	469
14	543	605	578	602	811	586	637	1477	879	366	630	430
15	559	647	568	729	890	256	1359	569	724	801	690	384
16	646	644	670	744	751	63	724	451	850	357	465	495
17	856	323	628	602	561	353	516	606	874	466	624	551
18	727	453	636	339	425	728	341	277	597	1226	544	561
19	581	636	686	3	611	1171	352	172	541	984	733	585
20	606	628	649	160	488	878	417	811	251	857	746	658
21	534	508	509	999	443	742	567	647	564	475	680	802
22	467	207	557	1713	148	336	747	910	853	317	875	836
23	530	181	479	1382	283	831	333	391	565	983	771	701
24	540	681	473	994	668	739	534	506	737	780	996	618
25	473	903	441	1060	1007	586	636	747	252	1410	842	544
26	398	1176	618	1143	913	1256	650	674	428	1205	837	538
27	585	862	532	1336	674	1334	504	1660	327	784	596	460
28	545	773	409	1325	654	737	759	1406	590	1265	610	433
29	522	789	275	997	537	240	860	1416	1303	1033	632	445
30	730	853	146	876	---	838	294	868	675	883	554	635
31	813	---	877	926	---	732	---	1113	---	582	586	---

Table A9. Surface water estimated daily mean outflow discharge at Lake River at Felida, WA (14211955) for water year 2013.

[Daily mean discharge, in cubic feet per second]

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	620	---	---	---	---	---	---	---	---	---	---	---
2	569	---	---	---	---	---	---	---	---	---	---	---
3	554	---	---	---	---	---	---	---	---	---	---	---
4	555	---	---	---	---	---	---	---	---	---	---	---
5	616	---	---	---	---	---	---	---	---	---	---	---
6	625	---	---	---	---	---	---	---	---	---	---	---
7	541	---	---	---	---	---	---	---	---	---	---	---
8	418	---	---	---	---	---	---	---	---	---	---	---
9	387	---	---	---	---	---	---	---	---	---	---	---
10	463	---	---	---	---	---	---	---	---	---	---	---
11	479	---	---	---	---	---	---	---	---	---	---	---
12	469	---	---	---	---	---	---	---	---	---	---	---
13	505	---	---	---	---	---	---	---	---	---	---	---
14	455	---	---	---	---	---	---	---	---	---	---	---
15	383	---	---	---	---	---	---	---	---	---	---	---
16	408	---	---	---	---	---	---	---	---	---	---	---
17	644	---	---	---	---	---	---	---	---	---	---	---
18	684	---	---	---	---	---	---	---	---	---	---	---
19	656	---	---	---	---	---	---	---	---	---	---	---
20	689	---	---	---	---	---	---	---	---	---	---	---
21	608	---	---	---	---	---	---	---	---	---	---	---
22	554	---	---	---	---	---	---	---	---	---	---	---
23	562	---	---	---	---	---	---	---	---	---	---	---
24	607	---	---	---	---	---	---	---	---	---	---	---
25	605	---	---	---	---	---	---	---	---	---	---	---
26	453	---	---	---	---	---	---	---	---	---	---	---
27	440	---	---	---	---	---	---	---	---	---	---	---
28	474	---	---	---	---	---	---	---	---	---	---	---
29	251	---	---	---	---	---	---	---	---	---	---	---
30	458	---	---	---	---	---	---	---	---	---	---	---
31	529	---	---	---	---	---	---	---	---	---	---	---

Appendix B. Quality-Assurance and Quality-Control Data

During this study, two changes related to laboratory and reporting guidelines were made at the U.S. Geological Survey (USGS) National Water Quality Laboratory (NWQL). Multiple topical quality-control samples were collected to document these changes and are summarized here. In addition, several types of routine quality-control data were collected for the water-quality parameters analyzed during the nutrient budget study. Details on these routine quality-control samples are provided in this appendix.

Changes to Water-Quality Methods

After about 1 year of sampling, the USGS NWQL announced they were switching analytical methods for the determination of nitrate plus nitrite from the cadmium reduction method to a new method that uses a nitrate reductase enzyme method (Patton and Krystalla, 2011). To make sure that the switch in analytical method halfway through the project would result in comparable data, paired samples were collected and analyzed for nitrate plus nitrite using both methods for all samples collected in December 2010 and January 2011. In total, 25 pairs of samples were analyzed using the two methods, and nitrate plus nitrite concentrations were comparable (fig. B1) for the entire range of nitrate concentration sampled (0.03–2.7 mg/L as N). Relative percent difference between the paired samples ranged from 0.1 to 14.4 percent, with 19 of the 25 pairs differing by less than 10 percent. There was slightly more deviation at concentrations greater than 2.0 mg/L as N. However, the close agreement for most of the samples indicated the switch in methods would not greatly influence our analysis and overall conclusions.

The second method change was a recommendation from the USGS Office of Water Quality memorandum on how to report total nitrogen concentration. This memorandum stated that total nitrogen of a sample should be calculated by summing the total dissolved nitrogen and particulate nitrogen concentrations, rather than using the total nitrogen concentration from the persulfate digestion of a whole water sample. Data collected over a multiyear study showed that sediments in whole water samples could produce a bias in total nitrogen concentrations (Rus and others, 2012). Because the waters of Vancouver Lake are quite turbid, the total nitrogen determined from digestion in the laboratory was compared to the calculated total nitrogen value for all samples collected during this study (fig. B2, n=204). In general, most total nitrogen concentrations determined from digestion were less than the corresponding calculated total nitrogen concentration, confirming Rus and others (2012) conclusion that digested total nitrogen produces a negative bias in the presence of sediment rich waters. As a result, all total nitrogen data presented in the report and subsequent total nitrogen budgets used the calculated total nitrogen value. If the digested total nitrogen data were used, it would lead to an underestimate of the actual nitrogen load to and from the lake.

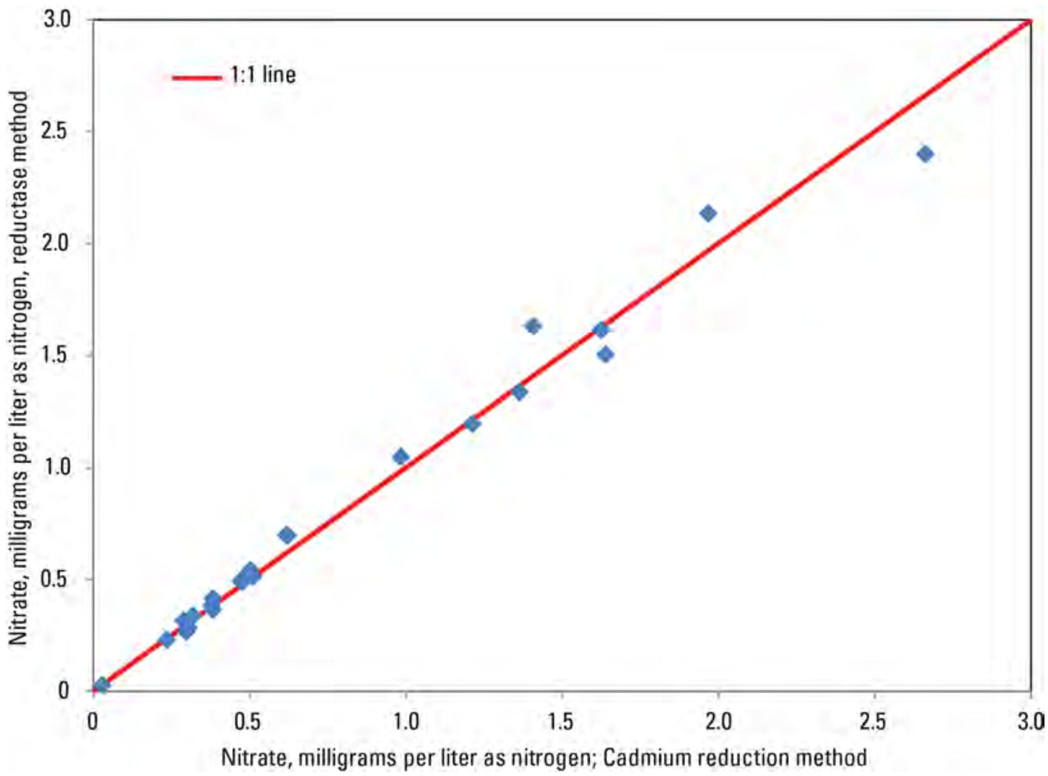

Figure B1. Graph showing comparison of nitrate plus nitrite concentration determined by the nitrate reductase method to the cadmium reduction method.

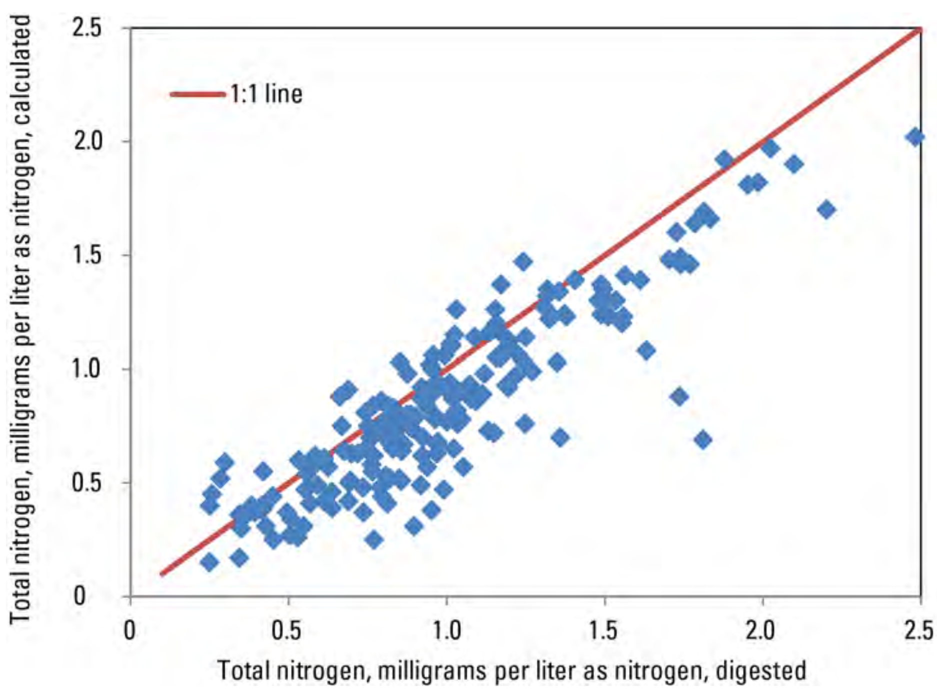

Figure B2. Graph showing comparison between calculated total nitrogen concentration and total nitrogen concentration measured using persulfate digestion method.

Quality-Control Data

Several types of routine quality-control data were collected during this study, including laboratory and field blanks, field replicates, and analysis of aqueous standard reference samples.

Laboratory and Field Blanks

During this study, a total of 19 blank samples were collected and analyzed for a number of parameters (table B1). Blank samples are used to evaluate contamination in collected samples. A source blank, three equipment blanks, and 15 field blanks were analyzed. Field blanks were collected across each type of water quality sample (tributary, groundwater, and lake water) and represented about 7 percent of the total number of samples collected. The number of blanks was a slightly less than the 10–15 percent recommended by USGS, but was not a cause for concern in this study. Field blanks measure the total bias in environmental samples owing to contamination. This contamination can result from improper washing, handling, and operating of field sampling equipment during field sample collection, sample processing, shipping, and preparation in the laboratory prior to analysis. Because field blanks represent all of the potential error, this type of blank sample is the most useful to analyze. Field blank data indicate that concentrations were less than the method detection limit for most parameters (table B1). Of all the analyzed parameters, ammonia showed the highest number of detections with 8 out of 11 samples having a concentration greater than the detection limit of 0.010 mg/L as N. However, these detections were still low with the highest concentration of 0.020 mg/L, and the remaining seven between 0.011 and 0.015 mg/L as N. There were no detections across all samples for total suspended solids, nitrate plus nitrite, orthophosphate, total dissolved phosphorus, total phosphorus, and total nitrogen. Particulate nitrogen and phosphorus were only detected in one sample but it was low. Total dissolved nitrogen was detected in five blank samples and ranged from 0.09 to 0.39 mg/L as N. Chlorophyll-*a* was detected in one of three field blanks. A source water blank, collected from the reverse osmosis system at the USGS laboratory in Tacoma, Washington, was used to clean all field equipment during the study and showed no detections for nutrients. Three equipment blanks (an equipment blank is the analysis of certified inorganic blank water added to a cleaned churn splitter and processed like an environmental sample) only showed small detections for particulate carbon and nitrogen. Overall, our blank data showed a low amount of bias in our samples and showed minimal contamination levels in environmental samples.

Field Replicates

Environmental variability was assessed from a minimum of 10 field replicates for most water-quality parameters (table B2). There were only three replicates collected for Chlorophyll-*a*. In most cases, the relative percent difference between the two replicates was less than 10 percent. In most cases where this difference was greater than 10 percent, concentrations were low, and absolute differences were minor.

Standard Reference Samples

Three standard reference samples were obtained from the USGS Branch of Quality Systems and submitted to the NWQL (table B3). The relative percent difference across all samples and analytes was almost always less than 10 percent indicating that NWQL was producing nutrient data of acceptable accuracy.

Table B1. Chemical results from source water blanks, equipment blanks, and field blanks, Vancouver, Washington, October 2010–October 2012.

[Bold values are greater than the method detection limit for that parameter. **Abbreviations**: mg/L, milligram per liter; N, nitrogen; P, phosphorus; µg/L, microgram per liter; --, no data; <, less than; E, estimated]

Site identifier	Date	Total suspended solids (mg/L)	Particulate carbon (mg/L)	Ammonia (mg/L as N)	Nitrate plus nitrite (mg/L as N)	Nitrite (mg/L as N)	Orthophosphate (mg/L as P)	Particulate nitrogen (mg/L)	Particulate phosphorus (mg/L)	Total dissolved phosphorus (mg/L as P)	Total phosphorus (mg/L as P)	Total dissolved nitrogen (mg/L as N)	Total nitrogen (mg/L as N)	Chlorophyll a (µg/L)	Pheophytin a (µg/L)
Source water blank															
Flushing Channel	10/22/2010	--	--	<0.010	<0.008	<0.001	<0.004	--	--	<0.003	<0.004	<0.05	<0.05	--	--
Equipment blanks															
Flushing Channel	10/22/2010	--	**0.13**	<0.010	<0.008	<0.001	<0.004	<0.017	--	<0.003	<0.004	<0.05	<0.05	--	--
Salmon Creek	10/4/2011	<1.1	**0.21**	<0.010	<0.010	<0.001	<0.004	<0.017	--	<0.003	<0.004	<0.01	<0.05	<0.1	<0.1
Salmon Creek	10/24/2012	<1.1	**0.06**	<0.010	<0.010	<0.001	<0.004	**0.036**	<0.0021	<0.003	<0.004	**0.31**	<0.05	--	--
Field blanks															
Flushing Channel	11/15/2010	--	<0.05	**0.020**	<0.008	<0.001	<0.004	<0.017	<0.0024	<0.003	<0.004	**0.39**	<0.05	--	--
Lake Site 2	8/16/2011	<1.1	**0.16**	**0.011**	<0.008	<0.001	<0.004	<0.017	<0.0024	<0.003	<0.004	**0.13**	<0.05	--	--
Flushing Channel	11/7/2011	<1.1	**0.05**	<0.010	<0.010	<0.001	<0.004	<0.017	<0.0021	<0.003	<0.004	<0.05	<0.05	--	--
Flushing Channel	7/12/2011	--	--	--	--	--	--	--	<0.0021	--	--	--	--	--	--
Burnt Bridge Creek	2/23/2012	<1.1	**0.09**	**0.014**	<0.010	<0.001	<0.004	**0.027**	**0.0024**	<0.003	<0.004	**0.07**	<0.05	--	--
Lake River	3/21/2012	<1.1	**0.12**	**0.014**	<0.010	<0.001	<0.004	<0.017	--	<0.003	<0.004	**0.05**	<0.05	--	--
Lake Site 2	4/10/2012	<1.1	**0.08**	**0.014**	<0.010	<0.001	<0.004	<0.017	<0.0021	<0.003	<0.004	<0.05	<0.05	--	--
Flushing Channel	5/15/2012	<1.1	<0.05	**0.015**	<0.010	<0.001	<0.004	<0.017	<0.0021	<0.003	<0.004	<0.05	<0.05	--	--
Lake Site 1	5/16/2012	--	--	--	--	--	--	--	--	--	--	--	--	<0.1	<0.1
Burnt Bridge Creek	6/21/2012	--	**0.07**	<0.010	<0.010	<0.001	<0.004	<0.017	<0.0021	<0.003	<0.004	<0.05	<0.05	--	--
Salmon Creek	7/16/2012	<1.1	**0.16**	**0.013**	<0.010	<0.001	<0.004	<0.017	<0.0021	<0.003	<0.004	**0.09**	<0.05	--	--
Burnt Bridge Creek	8/20/2012	<1.1	<0.05	**0.011**	<0.010	<0.001	<0.004	**0.022**	<0.0021	<0.003	<0.004	**0.12**	<0.05	--	--
Burnt Bridge Creek	9/26/2012	--	--	--	--	--	--	--	<0.0021	--	--	--	--	--	--
Lake River	10/25/2012	<1.1	<0.05	<0.010	<0.010	<0.001	<0.004	<0.017	<0.0021	<0.003	<0.004	<0.05	<0.05		
Lake Site 2	10/25/2012	--	--	--	--	--	--	--	--	--	--	--	--	**E0.36**	**E0.19**

Table B2. Results of all water quality field replicates, Lake Vancouver, Vancouver, Washington, October 2010–October 2012.

[Relative percent difference was calculated as the absolute difference of the sample and replicate value, divided by the average of these two values, which was then multiplied by 100 to get a percent. **Abbreviations**: mg/L, milligrams per liter; N, Nitrogen; P, phosphorus; µg/L, micrograms per liter]

Sampling site	Sample date	Sample value	Replicate value	Relative percent difference	Absolute difference
Total suspended solids (mg/L)					
Lake Site 1	1/17/2011	16	17	6.1	1.0
Lake River (OUT)	6/20/2011	5.2	8	42.4	2.8
Lake River (IN)	2/23/2012	46	15	101.6	31.0
Lake Site 1	3/20/2012	15	15	0.0	0.0
Flushing Channel	4/10/2012	6.4	6	6.5	0.4
Lake River (OUT)	7/16/2012	21	22	4.7	1.0
Salmon Creek	9/25/2012	4.8	2.8	52.6	2.0
Burnt Bridge Creek	10/24/2012	4	4	0.0	0.0
Particulate carbon (mg/L)					
Burnt Bridge Creek	11/16/2010	0.52	0.481	7.8	0.04
Burnt Bridge Creek	4/18/2011	0.688	0.911	27.9	0.22
Lake River (OUT)	9/13/2011	5.423	5.54	2.1	0.12
Lake Site 2	12/19/2011	1.279	1.348	5.3	0.07
Lake River (OUT)	2/23/2012	1.226	1.075	13.1	0.15
Flushing Channel	4/10/2012	0.52	0.472	9.7	0.05
Salmon Creek	9/25/2012	0.591	0.69	15.5	0.10
Burnt Bridge Creek	10/24/2012	1	0.474	71.4	0.53
Ammonia (mg/L as N)					
Burnt Bridge Creek	11/16/2010	0.081	0.076	6.4	0.01
Flushing Channel	7/11/2011	0.017	0.017	1.7	0.00
Salmon Creek	9/13/2011	0.030	0.031	5.2	0.00
Burnt Bridge Creek	11/8/2011	0.078	0.073	6.8	0.01
Lake River (OUT)	2/23/2012	0.025	0.023	6.0	0.00
Lake Site 1	3/20/2012	0.010	0.010	4.3	0.00
Lake Site 2	5/16/2012	0.083	0.033	87.7	0.05
Lake River (OUT)	7/16/2012	0.010	0.010	0.0	0.00
Salmon Creek	9/25/2012	0.026	0.022	17.1	0.00
Burnt Bridge Creek	10/24/2012	0.061	0.058	5.3	0.00
Site 2 drivepoint	10/26/2012	0.010	0.023	77.7	0.01

Sampling site	Sample date	Sample value	Replicate value	Relative percent difference	Absolute difference
Nitrate plus nitrite (mg/L as N)					
Flushing Channel	7/11/2011	0.041	0.041	0.0	0.00
Burnt Bridge Creek	11/16/2010	0.947	0.957	1.1	0.01
Burnt Bridge Creek	11/8/2011	1.051	1.172	10.9	0.12
Burnt Bridge Creek	10/24/2012	0.964	0.918	5.0	0.05
Lake Site 2	5/16/2012	0.034	0.032	4.6	0.00
Site 2 drivepoint	10/26/2012	2.582	2.564	0.7	0.02
Lake site 1	3/20/2012	0.266	0.267	0.5	0.00
Lake River (OUT)	2/23/2012	0.860	0.835	3.0	0.03
Lake River (OUT)	7/16/2012	0.010	0.010	0.0	0.00
Salmon Creek	9/13/2011	0.870	0.864	0.7	0.01
Salmon Creek	9/25/2012	1.346	1.341	0.4	0.01
Orthophosphate (mg/L as P)					
Flushing Channel	7/11/2011	0.004	0.004	0.2	0.00
Burnt Bridge Creek	11/16/2010	0.007	0.006	8.5	0.00
Burnt Bridge Creek	11/8/2011	0.007	0.011	43.8	0.00
Burnt Bridge Creek	10/24/2012	0.012	0.012	3.4	0.00
Lake Site 2	5/16/2012	0.018	0.014	17.6	0.00
Site 2 drivepoint	10/26/2012	0.045	0.045	0.4	0.00
Lake Site 1	3/20/2012	0.053	0.052	2.7	0.00
Lake River (OUT)	2/23/2012	0.053	0.061	13.5	0.01
Lake River (OUT)	7/16/2012	0.088	0.088	0.1	0.00
Salmon Creek	9/13/2011	0.092	0.099	7.4	0.01
Salmon Creek	9/25/2012	0.097	0.096	1.6	0.00
Particulate nitrogen (mg/L)					
Flushing Channel	4/10/2012	0.101	0.053	62.3	0.05
Burnt Bridge Creek	11/16/2010	0.063	0.057	10.0	0.01
Burnt Bridge Creek	4/18/2011	0.113	0.135	17.7	0.02
Burnt Bridge Creek	10/24/2012	0.103	0.051	67.5	0.05
Lake site 2	12/19/2011	0.219	0.235	7.0	0.02
Lake River (OUT)	9/13/2011	1.007	0.986	2.1	0.02
Lake River (OUT)	2/23/2012	0.161	0.145	10.5	0.02
Salmon Creek	9/25/2012	0.075	0.074	1.3	0.00

Sampling site	Sample date	Sample value	Replicate value	Relative percent difference	Absolute difference
Particulate phosphorus (mg/L)					
Flushing Channel	1/18/2011	0.028	0.029	2.1	0.00
Burnt Bridge Creek	11/16/2010	0.015	0.014	6.3	0.00
Burnt Bridge Creek	10/24/2012	0.013	0.013	2.3	0.00
Lake Site 1	3/20/2012	0.041	0.045	8.4	0.00
Lake River (OUT)	6/20/2011	0.025	0.025	2.0	0.00
Lake River (OUT)	2/23/2012	0.086	0.034	87.7	0.05
Salmon Creek	6/20/2012	0.045	0.037	18.8	0.01
Total dissolved phosphorus (mg/L as P)					
Flushing Channel	7/11/2011	0.014	0.013	7.5	0.00
Burnt Bridge Creek	11/16/2010	0.094	0.092	2.3	0.00
Burnt Bridge Creek	11/8/2011	0.058	0.068	14.9	0.01
Burnt Bridge Creek	10/24/2012	0.113	0.105	6.8	0.01
Lake Site 2	5/16/2012	0.021	0.019	9.6	0.00
Site 2 drivepoint	10/26/2012	0.106	0.056	62.1	0.05
Lake Site 1	3/20/2012	0.010	0.009	13.3	0.00
Lake River (OUT)	2/23/2012	0.027	0.026	2.3	0.00
Lake River (OUT)	7/16/2012	0.006	0.006	3.3	0.00
Salmon Creek	9/13/2011	0.046	0.046	0.4	0.00
Salmon Creek	9/25/2012	0.053	0.054	2.2	0.00
Total phosphorus (mg/L as P)					
Flushing Channel	7/11/2011	0.034	0.036	5.1	0.00
Burnt Bridge Creek	11/16/2010	0.125	0.123	1.0	0.00
Burnt Bridge Creek	11/8/2011	0.096	0.097	0.8	0.00
Burnt Bridge Creek	10/24/2012	0.132	0.131	1.1	0.00
Lake Site 2	5/16/2012	0.084	0.085	0.8	0.00
Site 2 drivepoint	10/26/2012	0.951	2.99	103.5	2.04
Lake Site 1	3/20/2012	0.065	0.063	2.3	0.00
Lake River (OUT)	2/23/2012	0.113	0.076	39.2	0.04
Lake River (OUT)	7/16/2012	0.105	0.104	1.2	0.00
Salmon Creek	9/13/2011	0.145	0.148	1.6	0.00
Salmon Creek	9/25/2012	0.088	0.091	2.3	0.00

Sampling site	Sample date	Sample value	Replicate value	Relative percent difference	Absolute difference
Total dissolved nitrogen (mg/L as N)					
Flushing Channel	7/11/2011	0.322	0.176	58.6	0.15
Burnt Bridge Creek	11/16/2010	0.592	0.293	67.6	0.30
Burnt Bridge Creek	10/24/2012	0.490	0.469	4.4	0.02
Lake Site 2	5/16/2012	0.649	0.804	21.3	0.16
Site 2 drivepoint	10/26/2012	1.095	1.044	4.8	0.05
Lake Site 1	3/20/2012	1.351	1.345	0.4	0.01
Lake River (OUT)	2/23/2012	1.398	1.432	2.4	0.03
Lake River (OUT)	7/16/2012	1.553	1.351	13.9	0.20
Salmon Creek	9/13/2011	1.706	1.757	2.9	0.05
Salmon Creek	9/25/2012	2.860	2.760	3.6	0.10
Total nitrogen (mg/L as N)					
Flushing Channel	7/11/2011	0.236	0.238	0.8	0.00
Burnt Bridge Creek	11/16/2010	1.391	1.391	0.0	0.00
Burnt Bridge Creek	11/8/2011	1.610	1.469	9.2	0.14
Burnt Bridge Creek	10/24/2012	1.306	1.300	0.5	0.01
Lake Site 2	5/16/2012	0.532	0.533	0.2	0.00
Site 2 drivepoint	10/26/2012	2.677	2.835	5.7	0.16
Lake Site 1	3/20/2012	0.752	0.732	2.7	0.02
Lake River (OUT)	2/23/2012	1.140	1.142	0.2	0.00
Lake River (OUT)	7/16/2012	0.761	0.764	0.4	0.00
Salmon Creek	9/13/2011	1.462	1.493	2.1	0.03
Salmon Creek	9/25/2012	1.640	1.661	1.3	0.02
Chlorophyll-*a* (µg/L)					
Lake Site 2	8/21/2012	31.66	31.35	1.0	0.31
Lake Site 2	9/25/2012	19.17	17.42	9.6	1.75
Lake Site 1	1/24/2012	10.67	10.49	1.7	0.18

Table B3. Results for nutrient standard reference samples submitted to the U.S. Geological Survey National Water Quality Laboratory.

[Most probable values are the results from the Fall 2011 inter laboratory comparison administered by the U.S. Geological Survey Branch of Quality Systems (BQS). Sample ID numbers in parenthesis represent the sample number assigned by BQS. **Abbreviations**: MPV, most probable value; mg/L, milligrams per liter; N, nitrogen; SRS, standard reference sample; P, phosphorus]

Sampling site	Sample date	Sample value	Sample MPV	Relative percent difference	Absolute difference
Ammonia (mg/L as N)					
Low nutrient SRS (N111)	12/7/2011	0.271	0.280	3.2	0.01
High nutrient SRS (N112)	12/7/2011	0.812	0.840	3.4	0.03
Diluted low nutrient SRS (N111)	12/7/2011	0.033	0.028	15.8	0.00
Nitrate plus nitrite (mg/L as N)					
Low nutrient SRS (N111)	12/7/2011	0.283	0.310	9.1	0.03
High nutrient SRS (N112)	12/7/2011	1.335	1.410	5.5	0.07
Diluted low nutrient SRS (N111)	12/7/2011	0.027	0.031	15.1	0.00
Orthophosphate (mg/L as P)					
Low nutrient SRS (N111)	12/7/2011	0.284	0.280	1.3	0.00
High nutrient SRS (N112)	12/7/2011	1.397	1.250	11.1	0.15
Diluted low nutrient SRS (N111)	12/7/2011	0.028	0.028	1.3	0.00
Total dissolved phosphorus (mg/L as P)					
Low nutrient SRS (N111)	12/7/2011	0.289	0.282	2.6	0.01
High nutrient SRS (N112)	12/7/2011	1.229	1.260	2.5	0.03
Diluted low nutrient SRS (N111)	12/7/2011	0.027	0.028	3.2	0.00
Total dissolved nitrogen (mg/L as N)					
Low nutrient SRS (N111)	12/7/2011	0.607	0.619	2.0	0.01
High nutrient SRS (N112)	12/7/2011	2.315	2.290	1.1	0.02
Diluted low nutrient SRS (N111)	12/7/2011	0.065	0.062	4.9	0.00

Appendix C. Tables of Water Quality Collected from Surface Waters and Groundwater, October 2010–October 2012

Appendix C tables are Microsoft® Excel files and can be downloaded from *http://pubs.usgs.gov/sir/2014/5201*.

Table C1. Water-quality data for Flushing Channel at Vancouver Lake, at Vancouver, Washington (14144805), October 2010–October 2012.

Table C2. Water-quality data for Burnt Bridge Creek at Vancouver Lake, near Vancouver, Washington (14211920), October 2010–October 2012.

Table C3. Water-quality data for Lake River at Felida, Washington (14144805), October 2010–October 2012.

Table C4. Water-quality data for Vancouver Lake Site 1 near Vancouver, Washington, October 2010–October 2012.

Table C5. Water-quality data for Vancouver Lake Site 2 near Vancouver, Washington, October 2010–October 2012.

Table C6. Water-quality data for shallow groundwater sites, near Vancouver, Washington, October 2010–October 2012.

Table C7. Water-quality data for Salmon Creek at Lake River, near Vancouver, Washington (14213050), October 2010–October 2012.

Appendix D. Lake Profiles for Temperature, Specific Conductivity, Dissolved Oxygen, pH, and Turbidity, October 2010–October 2012

Appendix D tables are Microsoft® Excel files and can be downloaded from *http://pubs.usgs.gov/sir/2014/5201*.

Table D1. Lake profiles of selected field parameters measured at Lake Site 1 (14211940), Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Table D2. Lake profiles of selected field parameters measured at Lake Site 2 (14211925), Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Table D3. Lake profiles of selected field parameters measured at Lake Site 3 (14211929), Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Appendix E. LOAD ESTimation Model Results and Comparison to Measured Load Data

This appendix summarizes results from the load estimation model (LOADEST) for Flushing Channel, Burnt Bridge Creek, Lake River, and Salmon Creek. The LOADEST procedure runs through nine separate flow contrasted with concentration models to arrive at the best fit model using Akaike information criterion (AIC) procedure and coefficients of the model are estimated using an adjusted maximum likelihood estimate (AMLE) procedure. Details of the LOADEST model selection and coefficient estimation are provided in Runkel and others (2004). Here we present the best fit models for total nitrogen, total phosphorus, and orthophosphate across the surface water sites in this study.

Flushing Channel

Total Nitrogen Model

The total nitrogen model for Flushing Channel is represented by the following equation:

$$\text{TN load} = a_{0+}a_1\ln Q+a_2\text{dtime}+a_3\sin(2\pi\text{dtime})+ a_4\cos(2\pi\text{dtime}) \qquad \text{(E1)}$$

where

Q	is the mean daily discharge in cubic feet per second, and
dtime	is the decimal time.

The coefficients (a_i) are provided in table E1. The R-squared of the regression was 83.05, indicating that the model explained 83 percent of the variability between the load and discharge.

A comparison between the modeled and measured loads is provided in figure E1and shows that the modeled load underestimates the measured loads by greater than 300 pounds of nitrogen per day. Overall, the mean relative percent difference between the modeled and measured loads was 20 percent during the 2-year study.

Table E1. Results for the total nitrogen load model from LOADEST for Flushing Channel, Vancouver Lake, Vancouver, Washington.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	4.44627316	0.05347438	1.17E-33
lnQ	0.88301669	0.16067219	1.61E-06
DECTIME	0.15972598	0.09793923	7.73E-02
sin.DECTIME	0.29853633	0.0883235	7.77E-04
cos.DECTIME	0.08193965	0.09699926	3.49E-01

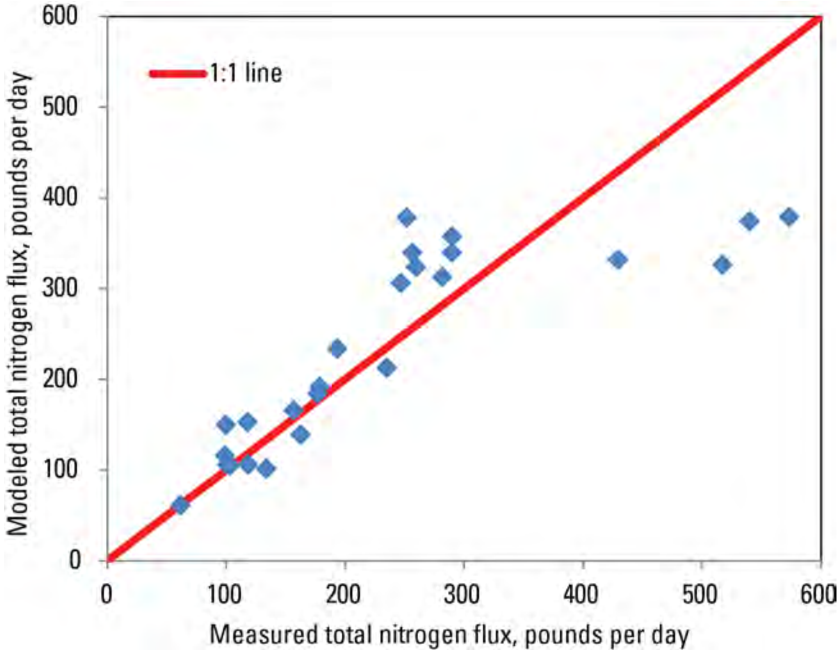

Figure E1. Comparison between the modeled and measured total nitrogen load at Flushing Channel, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Total Phosphorus Model

The total phosphorus (TP) model for Flushing Channel is represented by the following equation:

$$\text{TP load} = a_0 + a_1 \ln Q \qquad \text{(E2)}$$

The coefficients (a_i), are provided in table E2, and the R-squared of the regression was 69.51, indicating that the model explained about 70 percent of the variability between the load and discharge.

A comparison between the model simulated and measured loads is provided in figure E2 and shows a close correlation between the modeled and measured loads. Overall, the mean relative percent difference between the modeled and measured total phosphorus loads was 22 percent during the 2-year study.

Table E2. Results for the total phosphorus load model from LOADEST for Flushing Channel, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	1.8057864	0.05670688	1.71E-22
lnQ	0.9034036	0.12474634	5.05E-08

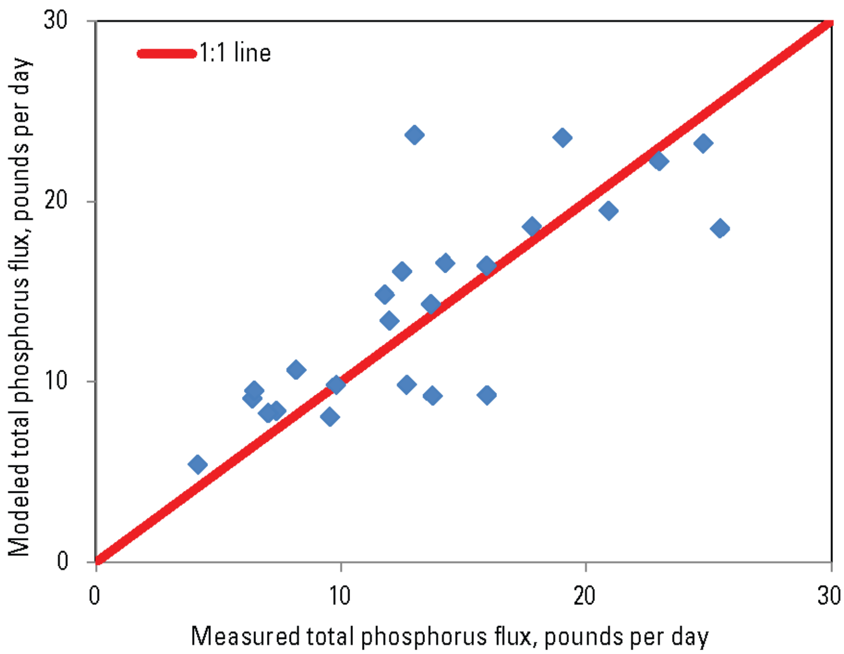

Figure E2. Comparison between the modeled and measured total phosphorus load at Flushing Channel, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Orthophosphate Model

The orthophosphate model for Flushing Channel is represented by the following equation:

$$\text{Orthophosphate load} = a_0+a_1\ln Q+a_2\text{dtime}+a_3\sin(2\pi\text{dtime})+ a_4\cos(2\pi\text{dtime}) \qquad \text{(E3)}$$

The coefficients (a_i), are provided in table E3, and the R-squared of the regression was 47.78, indicating that the model explained about 48 percent of the variability between the load and discharge.

A comparison between the model simulated and measured loads is provided in figure E3 and shows a close correlation between the modeled and measured loads. Overall, the mean relative percent difference between the modeled and measured total phosphorus loads was 32 percent during the 2-year study.

Table E3. Results for the orthophosphate load model from LOADEST for Flushing Channel, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	0.63303937	0.09250197	4.31E-07
lnQ	0.72864553	0.277968	9.68E-03
DECTIME	-0.39209934	0.16931388	1.47E-02
sin.DECTIME	-0.04559692	0.15254981	7.41E-01
cos.DECTIME	0.3253792	0.16741213	3.77E-02

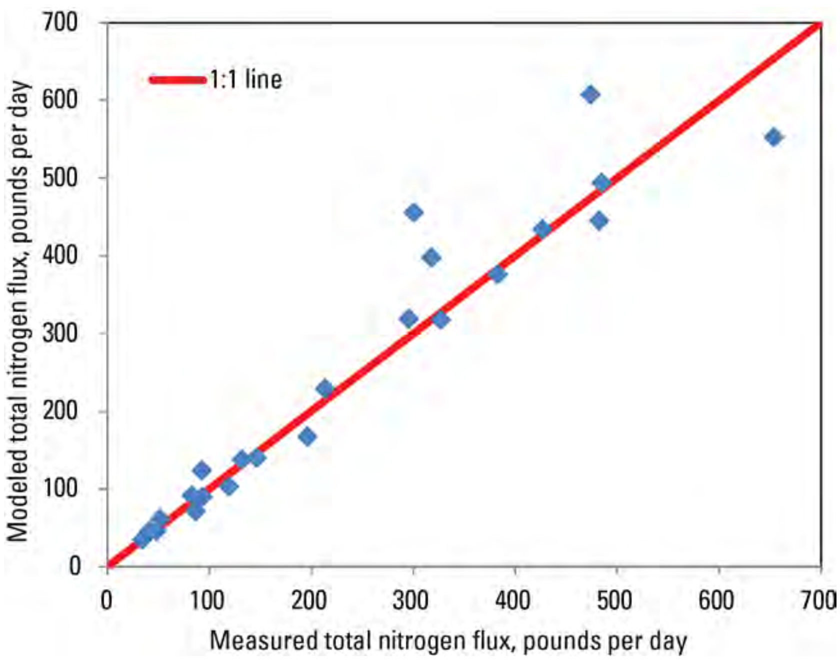

Figure E3. Comparison between the modeled and measured orthophosphate load at Flushing Channel, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Burnt Bridge Creek

Total Nitrogen Model

The total nitrogen (TN) model for Burnt Bridge Creek is represented by the following equation:

$$\text{TN load} = a_0 + a_1 \ln Q + a_2 \ln Q^2 + a_3 \sin(2\pi \text{dtime}) + a_4 \cos(2\pi \text{dtime}) \qquad \text{(E4)}$$

The coefficients (a_i) of the model are provided in table E4, and the R-squared of the regression was 97.36, indicating that the model explained 97 percent of the variability between the load and discharge.

A comparison between the model simulated and measured loads is provided in figure E4 and shows good agreement between the modeled and measured total nitrogen loads. Overall, the mean relative percent difference between the modeled and measured loads was 13 percent during the 2-year study.

Table E4. Results for the total nitrogen load model from LOADEST for Burnt Bridge Creek, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	4.7214316	0.062146	1.05E-31
lnQ	0.8795261	0.0891561	4.27E-11
LnQ2	-0.2709519	0.0716091	2.41E-04
sin.DECTIME	0.2330087	0.0895293	6.83E-03
cos.DECTIME	0.192574	0.0658253	2.81E-03

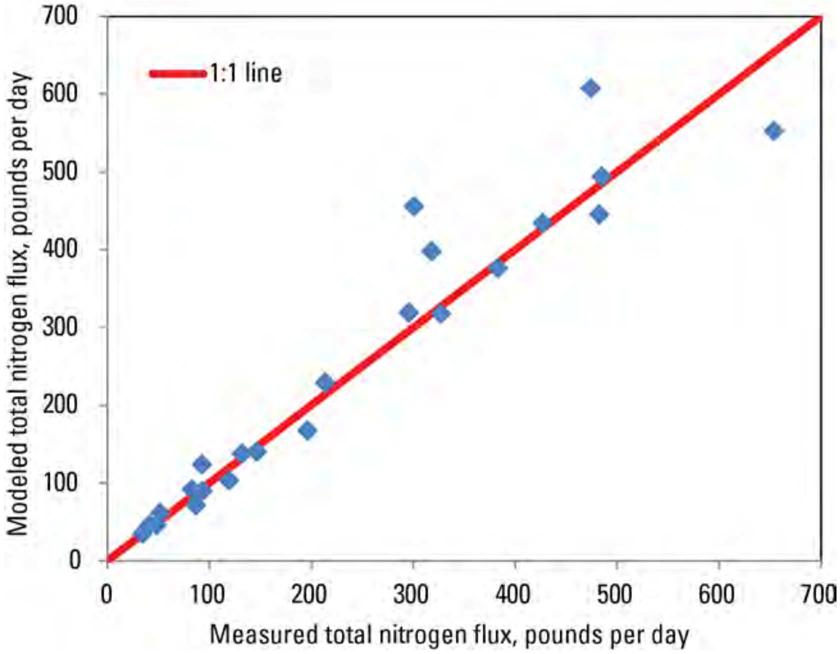

Figure E4. Comparison between the modeled and measured total nitrogen load at Burnt Bridge Creek, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Total Phosphorus Model

The total phosphorus model for Burnt Bridge Creek is represented by the following equation:

$$\text{TP load} = a_0 + a_1 \ln Q + a_2 \sin(2\pi dtime) + a_3 \cos(2\pi dtime) \qquad \text{(E5)}$$

The coefficients (a_i), are provided in table E5, and the R-squared of the regression was 93.57, indicating that the model explained about 94 percent of the variability between the load and discharge.

A comparison between the model simulated and measured loads shows a close correlation between the modeled and measured loads (fig. E5). Overall, the mean relative percent difference between the modeled and measured total phosphorus loads was 14 percent during the 2-year study.

Table E5. Results for the total phosphorus load model from LOADEST for Burnt Bridge Creek, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	1.9454469	0.0485822	9.40E-25
lnQ	1.1758388	0.1110659	1.69E-11
sin.DECTIME	-0.2236766	0.1092629	3.26E-02
cos.DECTIME	-0.1221783	0.084213	1.21E-01

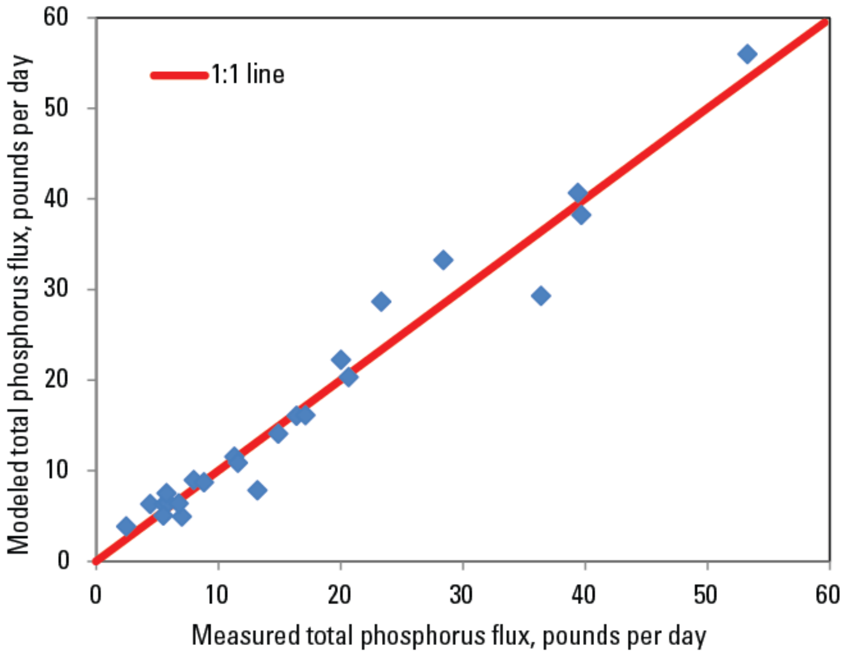

Figure E5. Comparison between the modeled and measured total phosphorus load at Burnt Bridge Creek, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Orthophosphate Model

The orthophosphate model for Burnt Bridge Creek is represented by the following equation:

$$\text{Orthophosphate load} = a_0 + a_1 \ln Q + a_2 \ln Q^2 + a_3 \sin(2\pi \text{dtime}) + a_4 \cos(2\pi \text{dtime}) \qquad \text{(E6)}$$

The coefficients (a_i), are provided in table E6, and the R-squared of the regression was 91.08, indicating that the model explained about 91 percent of the variability between the load and discharge.

A comparison between the model simulated and measured loads shows a close correlation between the modeled and measured loads (fig. E6). Overall, the mean relative percent difference between the modeled and measured total phosphorus loads was 20 percent during the 2-year study.

Table E6. Results for the orthophosphate load model from LOADEST for Burnt Bridge Creek, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	1.4008079	0.1136578	3.85E-13
lnQ	1.1058935	0.1630562	5.54E-08
LnQ2	-0.2485961	0.1309647	4.12E-02
sin.DECTIME	-0.2157326	0.1637385	1.47E-01
cos.DECTIME	0.2471085	0.1203867	2.83E-02

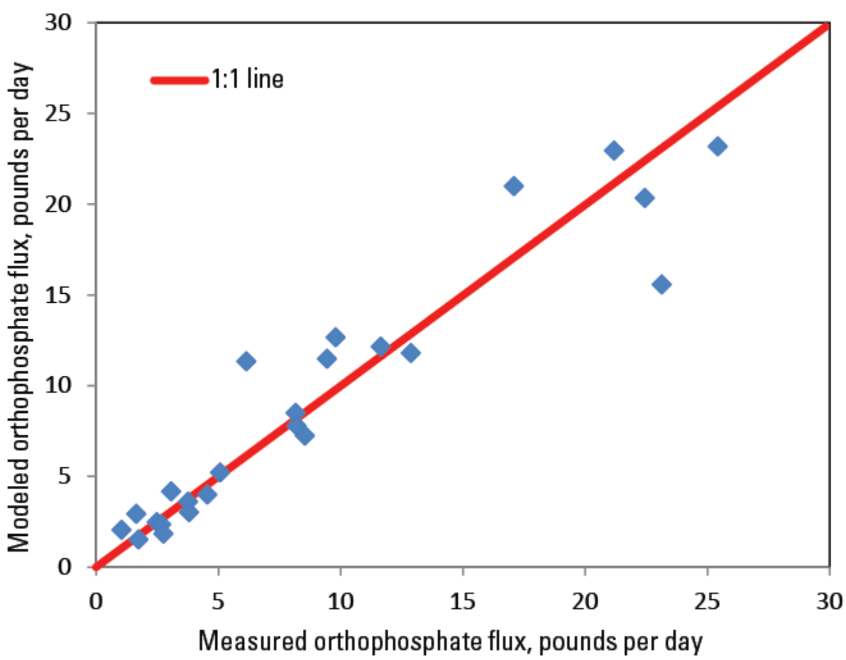

Figure E6. Comparison between the modeled and measured orthophosphate load at Burnt Bridge Creek, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Lake River IN

Total Nitrogen Model

The total nitrogen model for Lake River at Felida when it flows into the lake (Lake River IN) is represented by the following equation:

$$\text{TN load} = a_0 + a_1\ln Q + a_2\ln Q^2 + a_3\text{dtime} + a_4\sin(2\pi\text{dtime}) + a_5\cos(2\pi\text{dtime}) \qquad \text{(E7)}$$

The coefficients (a_i) of the model are provided in table E7, and the R-squared of the regression was 95.13, indicating that the model explained 95 percent of the variability between the load and discharge.

A comparison between the model simulated and measured loads is provided in figure E7. Overall, the mean relative percent difference between the modeled and measured loads was 15 percent during the 2-year study.

Table E7. Results for the total nitrogen load model from LOADEST for Lake River at Felida IN, , Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	7.640826	0.0520449	6.93E-39
lnQ	1.18467	0.0688442	1.19E-16
lnQ2	-0.1080136	0.0500413	1.88E-02
DECTIME	-0.1543067	0.0870475	4.94E-02
sin.DECTIME	-0.203149	0.0655161	1.35E-03
cos.DECTIME	0.1636808	0.0677804	9.45E-03

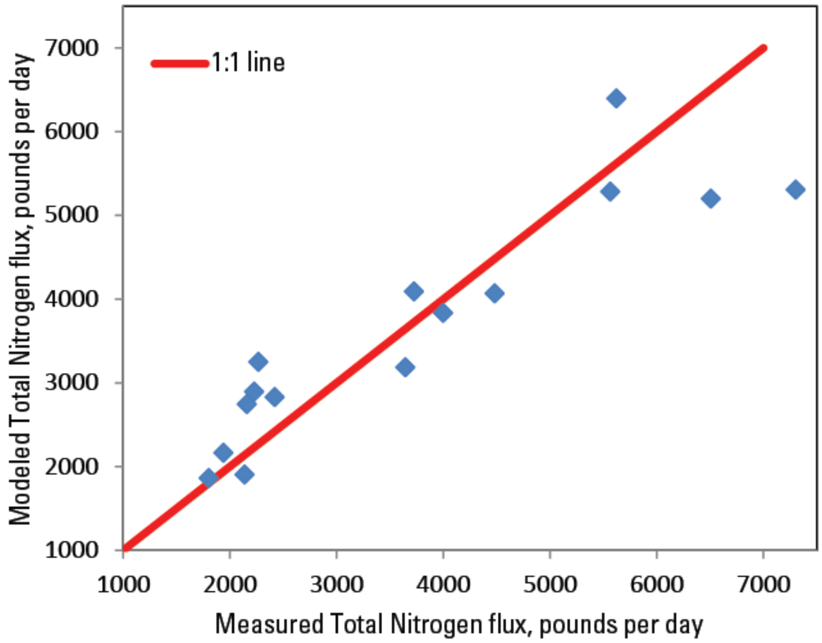

Figure E7. Comparison between the modeled and measured total nitrogen load at Lake River IN, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Total Phosphorus Model

The total phosphorus model for Lake River IN is represented by the following equation:

$$\text{TP load} = a_0 + a_1\ln Q + a_2\ln Q^2 + a_3\sin(2\pi \text{dtime}) + a_4\cos(2\pi \text{dtime}) \quad \text{(E8)}$$

The coefficients (a_i), are provided in table E8, and the R-squared of the regression was 90.65, indicating that the model explained about 91 percent of the variability between the load and discharge.

A comparison between the model simulated and measured loads shows a close correlation between the modeled and measured loads (fig. E8). Overall, the mean relative percent difference between the modeled and measured total phosphorus loads was 19 percent during the 2-year study.

Table E8. Results for the total phosphorus load model from LOADEST for Lake River at Felida IN, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	5.37396104	0.0661756	2.11E-32
lnQ	1.13848738	0.0864603	9.06E-14
lnQ2	-0.15963279	0.0608996	6.49E-03
sin.DECTIME	-0.39462434	0.0828034	1.40E-05
cos.DECTIME	0.02361345	0.0817931	7.46E-01

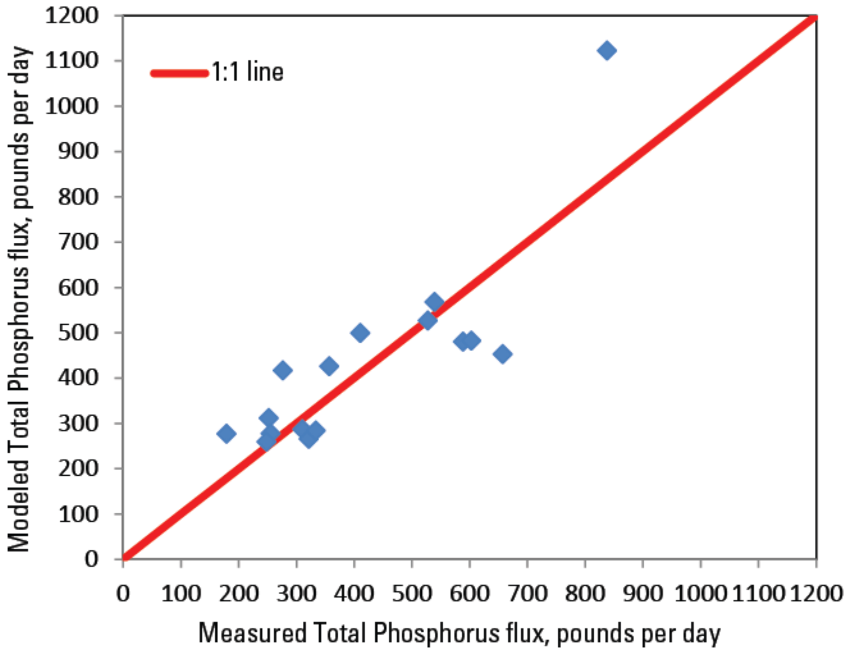

Figure E8. Comparison between the modeled and measured total phosphorus load at Lake River IN, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Orthophosphate Model

The orthophosphate model for Lake River IN is represented by the following equation:

$$\text{Orthophosphate load} = a_0{+}a_1\ln Q{+}\ a_2\sin(2\pi \text{dtime}){+}\ a_3\cos(2\pi \text{dtime}) \qquad \text{(E9)}$$

The coefficients (a_i), are provided in table E9, and the R-squared of the regression was 75.25, indicating that the model explained about 75 percent of the variability between the load and discharge.

A comparison between the model simulated and measured loads shows some scatter between the modeled and measured loads (fig. E9). Overall, the mean relative percent difference between the modeled and measured total phosphorus loads was 50 percent during the 2-year study.

Table E9. Results for the orthophosphate load model from LOADEST for Lake River at Felida IN, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	3.2256831	0.1278863	1.13E-17
lnQ	1.4112959	0.1951691	4.75E-08
sin.DECTIME	-0.3488284	0.1813313	4.46E-02
cos.DECTIME	0.2774514	0.1794138	9.72E-02

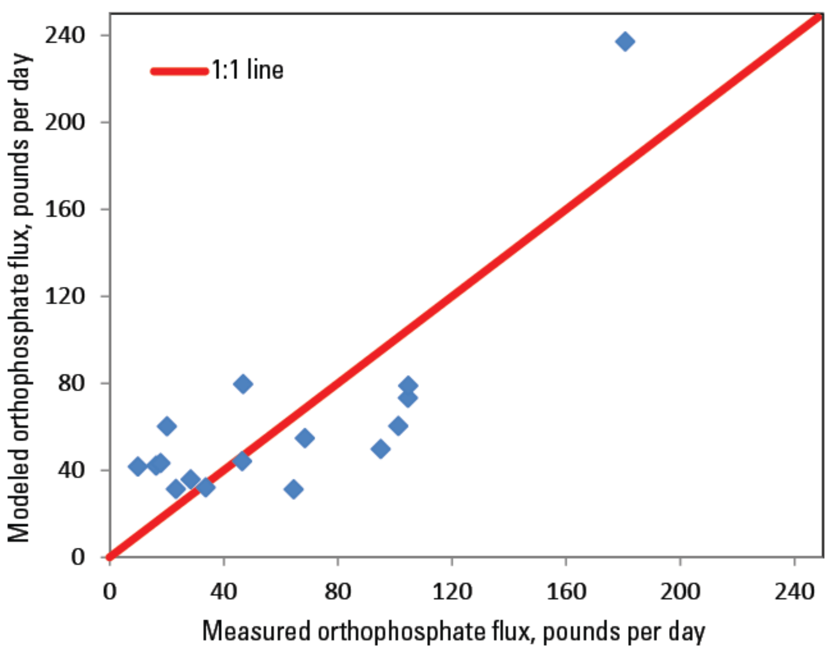

Figure E9. Comparison between the modeled and measured orthophosphate load at Lake River IN, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Lake River OUT

Total Nitrogen Model

The total nitrogen model for Lake River at Felida when it flows out of the lake (Lake River OUT) is represented by the following equation:

$$TN\ load = a_0 + a_1 \ln Q + a_2 \ln Q^2 + a_3 \sin(2\pi dtime) + a_4 \cos(2\pi dtime) \qquad (E10)$$

The coefficients (a_i) of the model are provided in table E10, and the R-squared of the regression was 81.87, indicating that the model explained 82 percent of the variability between the load and discharge.

A comparison between the model simulated and measured loads is provided in figure E10. Overall, the mean relative percent difference between the modeled and measured loads was 17 percent during the 2-year study.

Table E10. Results for the total nitrogen load model from LOADEST for Lake River at Felida OUT, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	7.4266468	0.0673735	5.56E-31
lnQ	0.7176743	0.111948	2.80E-07
lnQ2	-0.2900275	0.1836512	7.94E-02
sin.DECTIME	-0.149453	0.0792534	3.91E-02
cos.DECTIME	0.2133994	0.0819343	6.30E-03

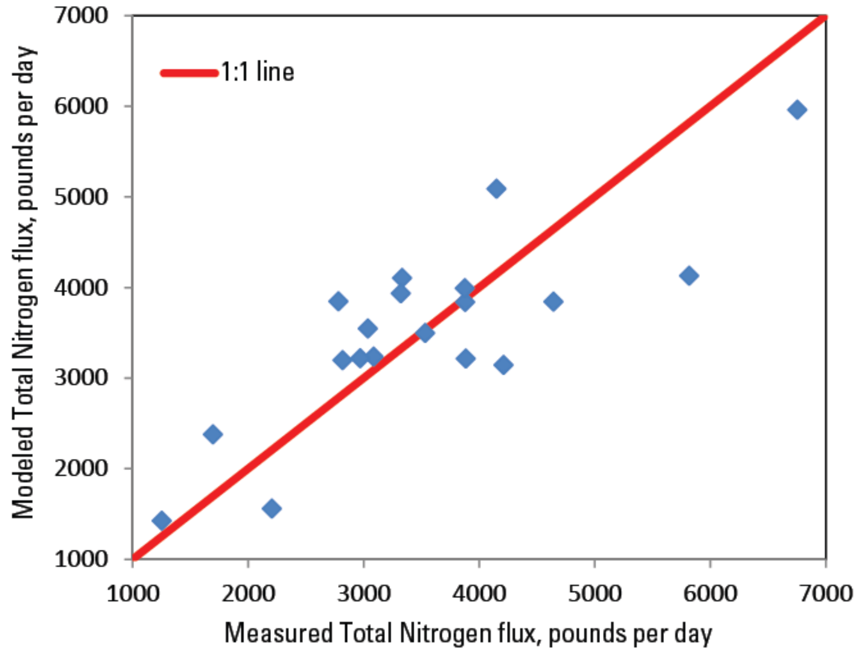

Figure E10. Comparison between the simulated and measured total nitrogen load at Lake River OUT, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Total Phosphorus Model

The total phosphorus model for Lake River OUT is represented by the following equation:

$$\text{TP load} = a_0 + a_1 \ln Q + a_2 \ln Q^2 + a_3 \sin(2\pi \text{dtime}) + a_4 \cos(2\pi \text{dtime}) \quad \text{(E11)}$$

The coefficients (a_i), are provided in table E11, and the R-squared of the regression was 78.95, indicating that the model explained about 79 percent of the variability between the load and discharge.

Table E11. Results for the total phosphorus load model from LOADEST for Lake River at Felida OUT, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	5.1019057	0.0898587	3.46E-25
lnQ	0.9243581	0.1493095	4.74E-07
lnQ2	-0.6008445	0.2449429	9.40E-03
sin.DECTIME	-0.3521051	0.1057033	8.75E-04
cos.DECTIME	-0.1253605	0.109279	1.95E-01

A comparison between the simulated and measured loads shows a close correlation between the modeled and measured loads (fig. E11). Overall, the mean relative percent difference between the modeled and measured total phosphorus loads was 21 percent during the 2-year study.

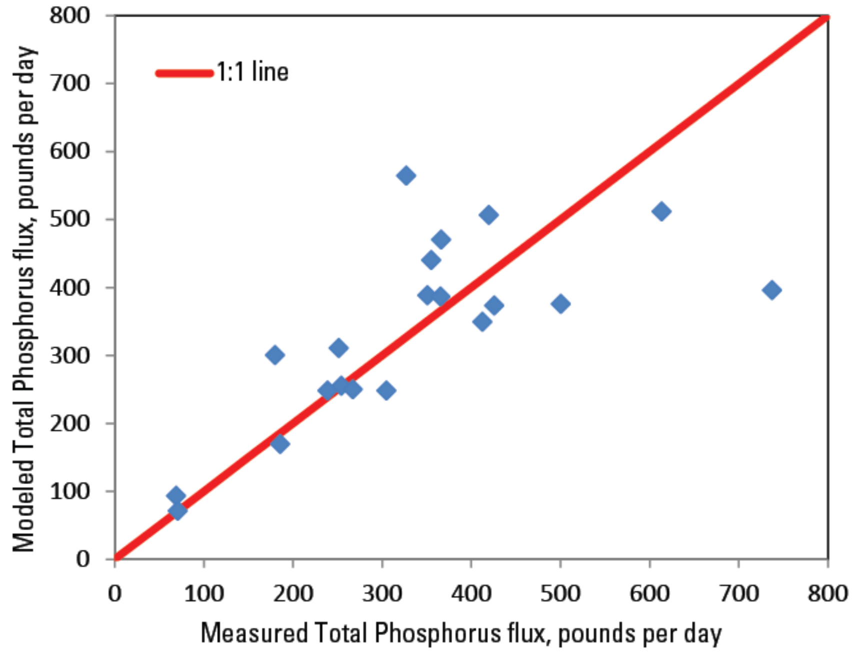

Figure E11. Comparison between the simulated and measured total phosphorus load at Lake River OUT, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Orthophosphate Model

The orthophosphate model for Lake River OUT is represented by the following equation:

$$\text{Orthophosphate load} = a_0 + a_1 \ln Q + a_2 \ln Q^2 + a_3 \text{dtime} + a_4 \text{dtime}^2 + a_5 \sin(2\pi \text{dtime}) + a_6 \cos(2\pi \text{dtime}) \quad \text{(E12)}$$

The coefficients (a_i), are provided in table E12, and the R-squared of the regression was 75.25, indicating that the model explained about 75 percent of the variability between the load and discharge.

Table E12. Results for the orthophosphate load model from LOADEST for Lake River at Felida OUT, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	2.5150221	0.2229021	1.46E-10
lnQ	1.3401348	0.2801992	7.60E-06
lnQ2	-0.3135458	0.449191	3.63E-01
DECTIME	-0.2316675	0.2447658	2.47E-01
DECTIME2	1.1388479	0.458025	5.89E-03
sin.DECTIME	-0.3498263	0.1964876	4.03E-02
cos.DECTIME	-0.1433366	0.2028334	3.81E-01

A comparison between the simulated and measured loads shows some scatter between the modeled and measured loads (fig. E12). Overall, the mean relative percent difference between the modeled and measured total phosphorus loads was 35 percent during the 2-year study.

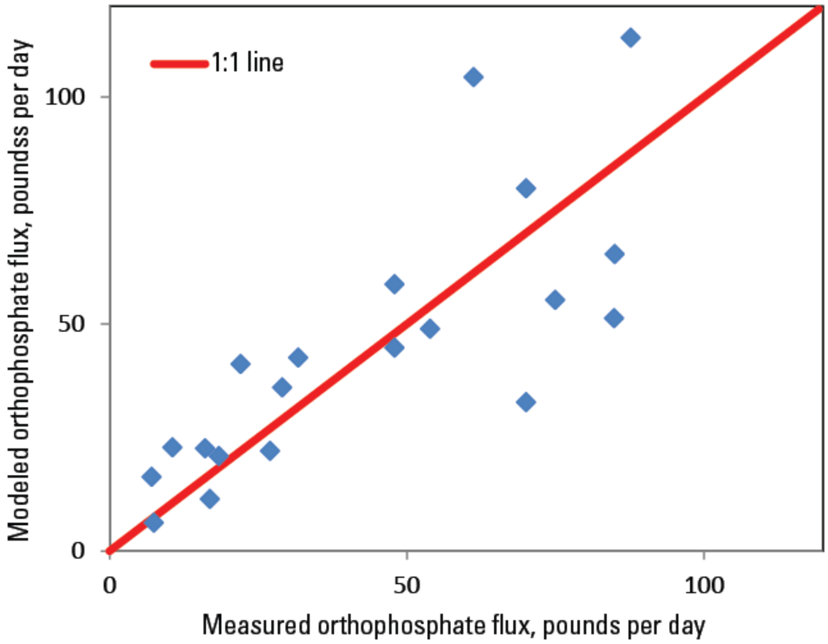

Figure E12. Comparison between the simulated and measured orthophosphate load at Lake River OUT, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Salmon Creek

Total Nitrogen Model

The total nitrogen model for Salmon Creek is represented by the following equation:

$$\text{TN load} = a_0 + a_1 \ln Q + a_2 \sin(2\pi dtime) + a_3 \cos(2\pi dtime) \quad \text{(E13)}$$

The coefficients (a_i) of the model are provided in table E13, and the R-squared of the regression was 95.9, indicating that the model explained 96 percent of the variability between the load and discharge.

Table E13. Results for the total nitrogen load model from LOADEST for Salmon Creek at Lake River, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	6.22801024	0.0556672	2.45E-34
lnQ	0.84083714	0.104459	5.15E-09
sin.DECTIME	0.02829916	0.1492791	8.35E-01
cos.DECTIME	0.33684312	0.1106412	2.50E-03

A comparison between the simulated and measured loads is provided in figure E13. Overall, the mean relative percent difference between the modeled and measured loads was 15 percent during the 2-year study.

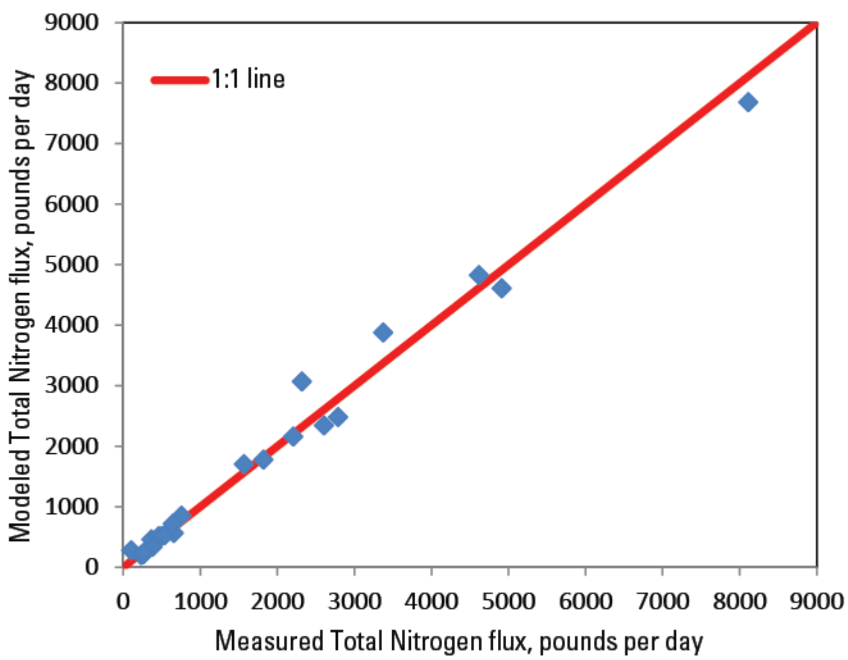

Figure E13. Comparison between the simulated and measured total nitrogen load at Salmon Creek, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Total Phosphorus Model

The total phosphorus model for Salmon Creek is represented by the following equation:

$$\text{TP load} = a_0 + a_1 \ln Q + a_2 \ln Q^2 \qquad \text{(E15)}$$

The coefficients (a_i), are provided in table E14, and the R-squared of the regression was 93.16, indicating that the model explained about 93 percent of the variability between the load and discharge.

A comparison between the simulated and measured loads shows a close correlation between the modeled and measured loads except for one high value (fig. E14). Overall, the mean relative percent difference between the modeled and measured total phosphorus loads was 22 percent during the 2-year study.

Table E14. Results for the total phosphorus load model from LOADEST for Salmon Creek at Lake River, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	3.1465369	0.0993974	1.87E-21
lnQ	0.8405021	0.052047	6.44E-15
lnQ2	0.1911391	0.0564302	1.24E-03

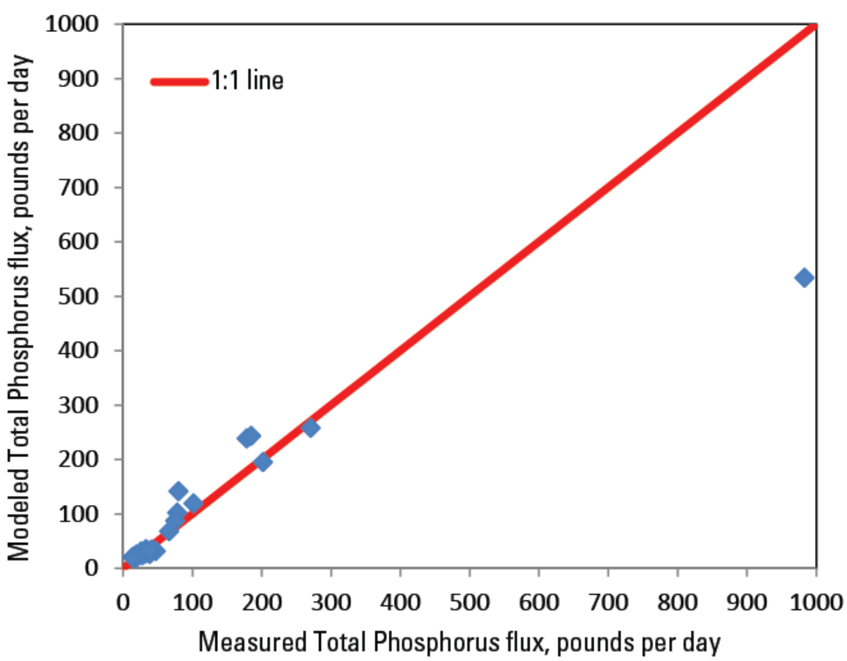

Figure E14. Comparison between the simulated and measured total phosphorus load at Salmon Creek, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Orthophosphate Model

The orthophosphate model for Salmon Creek is represented by the following equation:

$$\text{Orthophosphate load} = a_0 + a_1 \ln Q + a_2 \sin(2\pi dtime) + a_3 \cos(2\pi dtime) \quad \text{(E16)}$$

The coefficients (a_i), are provided in table E15, and the R-squared of the regression was 89.62, indicating that the model explained about 90 percent of the variability between the load and discharge.

A comparison between the simulated and measured loads shows good agreement between the modeled and measured loads (fig. E15). Overall, the mean relative percent difference between the modeled and measured total phosphorus loads was 22 percent during the 2-year study.

Table E15. Results for the orthophosphate load model from LOADEST for Salmon Creek at Lake River, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Coefficient (a_i)	Standard deviation	P-value
Intercept	2.3407465	0.0781266	3.65E-21
lnQ	0.8762555	0.146604	8.11E-07
sin.DECTIME	-0.4112127	0.2095073	3.93E-02
cos.DECTIME	0.3208435	0.1552806	3.08E-02

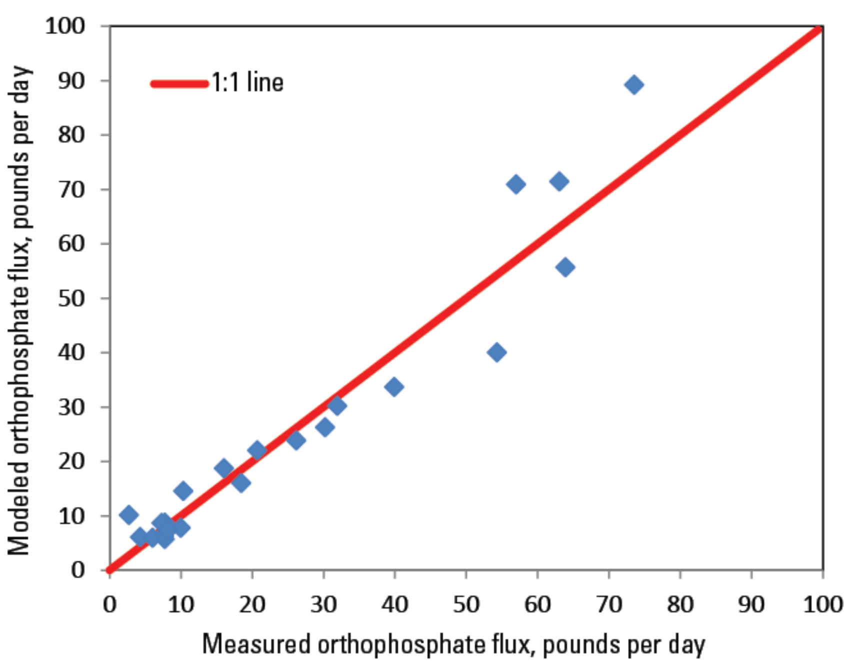

Figure E15. Comparison between the simulated and measured orthophosphate load at Salmon Creek, Vancouver Lake, Vancouver, Washington, October 2010–October 2012.

Appendix F. Monthly Surface-Water Load Estimates and Error Analysis from LOAD ESTimation Model, October 2010–October 2012

Table F1. Estimates and error analysis for monthly loads determined from LOADEST model for Flushing Channel at Vancouver Lake, 14144805, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
		Total nitrogen		
October 2010	2,449	16	1,777	3,291
November 2010	2,323	15	1,723	3,064
December 2010	4,551	14	3,460	5,877
January 2011	7,091	14	5,350	9,219
February 2011	5,116	12	4,019	6,420
March 2011	8,327	11	6,654	10,293
April 2011	9,236	11	7,349	11,458
May 2011	10,122	12	7,973	12,673
June 2011	10,327	13	7,934	13,215
July 2011	6,622	12	5,168	8,359
August 2011	3,973	12	3,121	4,986
September 2011	3,129	11	2,493	3,877
October 2011	3,292	11	2,652	4,040
November 2011	3,430	11	2,748	4,229
December 2011	4,386	11	3,487	5,447
January 2012	7,772	13	5,994	9,913
February 2012	5,934	12	4,632	7,488
March 2012	10,310	11	8,206	12,788
April 2012	13,283	12	10,510	16,563
May 2012	11,953	11	9,522	14,814
June 2012	10,830	12	8,526	13,565
July 2012	9,092	12	7,085	11,492
August 2012	4,521	12	3,541	5,688
September 2012	3,546	13	2,741	4,512
October 2012	3,662	14	2,771	4,748

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
Total Phosphorus				
October 2010	271	10	221	329
November 2010	225	12	178	281
December 2010	374	8	318	437
January 2011	493	8	416	580
February 2011	316	9	266	372
March 2011	490	8	417	573
April 2011	557	9	469	658
May 2011	682	10	557	825
June 2011	796	12	631	991
July 2011	579	9	485	686
August 2011	385	8	327	449
September 2011	310	9	259	368
October 2011	308	9	257	367
November 2011	284	10	235	340
December 2011	303	9	252	360
January 2012	461	8	392	539
February 2012	311	9	260	368
March 2012	517	8	437	608
April 2012	689	10	560	840
May 2012	679	10	558	818
June 2012	715	11	578	874
July 2012	685	10	562	828
August 2012	373	8	317	436
September 2012	300	9	250	357
October 2012	292	10	241	351

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
Orthophosphate				
October 2010	161	28	90	267
November 2010	153	27	89	247
December 2010	239	24	146	370
January 2011	278	24	169	432
February 2011	171	22	110	254
March 2011	209	20	139	301
April 2011	190	20	126	276
May 2011	187	21	122	275
June 2011	192	23	119	294
July 2011	147	22	94	219
August 2011	114	21	74	168
September 2011	108	20	72	156
October 2011	123	19	84	176
November 2011	126	19	85	180
December 2011	137	20	91	198
January 2012	181	22	114	272
February 2012	115	22	73	172
March 2012	144	20	95	208
April 2012	150	21	99	220
May 2012	128	20	85	185
June 2012	119	21	77	176
July 2012	114	22	73	171
August 2012	75	22	48	111
September 2012	70	23	44	107
October 2012	79	25	48	124

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
Total Suspended Solids				
October 2010	38,053	16	27,235	51,759
November 2010	29,760	19	20,314	42,115
December 2010	60,421	13	46,014	77,918
January 2011	90,472	15	67,342	119,009
February 2011	49,764	14	37,363	64,972
March 2011	87,529	14	66,363	113,316
April 2011	104,424	14	78,102	136,791
May 2011	137,543	17	97,785	188,150
June 2011	170,476	19	115,945	241,979
July 2011	109,955	15	81,240	145,560
August 2011	61,829	13	47,263	79,476
September 2011	46,407	15	34,474	61,149
October 2011	45,588	15	33,686	60,346
November 2011	41,715	15	30,524	55,684
December 2011	45,564	15	33,773	60,154
January 2012	81,481	14	61,412	106,031
February 2012	47,247	14	35,262	62,006
March 2012	95,123	14	70,982	124,857
April 2012	141,032	17	99,221	194,626
May 2012	135,605	16	97,656	183,489
June 2012	147,273	17	103,365	203,648
July 2012	137,434	16	98,649	186,482
August 2012	59,271	13	45,144	76,427
September 2012	44,531	15	32,905	58,946
October 2012	42,023	16	30,573	56,372

Table F2. Estimates and error analysis for monthly loads determined from LOADEST model for Burnt Bridge Creek at Vancouver Lake, 14211920, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
		Total nitrogen		
October 2010	4,285	10	3,496	5,199
November 2010	8,896	11	7,158	10,927
December 2010	13,524	9	11,330	16,017
January 2011	13,683	7	11,941	15,606
February 2011	10,257	8	8,687	12,028
March 2011	16,157	6	14,257	18,238
April 2011	13,005	6	11,446	14,717
May 2011	9,058	7	7,809	10,450
June 2011	4,584	7	3,948	5,292
July 2011	3,261	8	2,799	3,778
August 2011	2,006	7	1,749	2,289
September 2011	1,669	7	1,442	1,921
October 2011	3,025	7	2,611	3,487
November 2011	6,677	9	5,577	7,929
December 2011	6,390	7	5,503	7,379
January 2012	12,563	7	10,982	14,305
February 2012	10,721	8	9,066	12,590
March 2012	14,586	6	12,824	16,521
April 2012	11,499	7	10,073	13,070
May 2012	7,436	7	6,440	8,541
June 2012	5,124	8	4,371	5,968
July 2012	2,573	7	2,248	2,931
August 2012	1,530	8	1,309	1,776
September 2012	1,125	11	910	1,376
October 2012	3,914	10	3,223	4,708

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
Total Phosphorus				
October 2010	410	13	317	522
November 2010	733	13	566	933
December 2010	1,140	13	877	1,457
January 2011	718	9	600	852
February 2011	403	11	324	496
March 2011	832	8	703	977
April 2011	757	9	636	894
May 2011	548	9	460	647
June 2011	317	9	265	375
July 2011	288	9	239	345
August 2011	207	9	173	247
September 2011	174	9	145	208
October 2011	254	9	211	305
November 2011	587	13	447	756
December 2011	350	10	287	422
January 2012	784	10	644	945
February 2012	413	11	331	509
March 2012	816	9	686	963
April 2012	598	9	503	706
May 2012	429	9	359	508
June 2012	376	9	312	449
July 2012	228	9	190	271
August 2012	166	9	138	198
September 2012	129	10	106	155
October 2012	355	12	281	443

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
Orthophosphate				
October 2010	242	20	160	351
November 2010	505	20	333	736
December 2010	715	17	506	982
January 2011	536	13	415	681
February 2011	299	15	219	399
March 2011	469	12	371	585
April 2011	355	12	279	445
May 2011	244	14	185	317
June 2011	130	14	99	169
July 2011	113	14	84	148
August 2011	80	13	62	102
September 2011	76	14	58	98
October 2011	151	14	114	196
November 2011	369	18	258	512
December 2011	270	14	204	351
January 2012	497	13	383	635
February 2012	310	16	227	415
March 2012	419	12	329	528
April 2012	300	12	234	379
May 2012	193	13	147	248
June 2012	152	15	113	202
July 2012	85	13	66	108
August 2012	59	14	44	78
September 2012	48	20	32	70
October 2012	216	19	146	307

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
Total suspended solids				
October 2010	22,731	28	12,728	37,610
November 2010	44,230	27	25,133	72,373
December 2010	75,794	33	38,212	135,458
January 2011	54,836	28	30,707	90,725
February 2011	33,600	26	19,583	53,926
March 2011	67,592	29	36,954	113,853
April 2011	58,161	29	31,755	98,066
May 2011	38,686	26	22,823	61,511
June 2011	20,088	26	11,825	31,994
July 2011	16,281	27	9,317	26,498
August 2011	10,958	31	5,813	18,875
September 2011	9,164	33	4,674	16,244
October 2011	14,202	28	7,954	23,493
November 2011	35,653	32	18,540	62,311
December 2011	24,646	27	14,003	40,331
January 2012	59,103	33	29,669	105,956
February 2012	34,478	26	20,387	54,725
March 2012	65,501	32	34,095	114,391
April 2012	46,677	28	26,483	76,466
May 2012	30,463	26	18,028	48,321
June 2012	23,645	26	13,889	37,722
July 2012	12,933	29	7,115	21,683
August 2012	8,778	33	4,399	15,755
September 2012	6,767	37	3,164	12,754
October 2012	19,877	28	11,188	32,761

Table F3. Estimates and error analysis for monthly loads determined from LOADEST model for Lake River at Felida flowing IN, 14211955, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
Total nitrogen				
October 2010	133,714	14	101,637	172,724
November 2010	145,696	12	113,648	183,982
December 2010	177,163	11	141,586	218,955
January 2011	156,020	12	123,691	194,210
February 2011	96,209	10	78,218	117,092
March 2011	132,524	10	108,853	159,801
April 2011	118,331	10	95,939	144,371
May 2011	132,306	10	107,418	161,221
June 2011	57,845	11	46,386	71,274
July 2011	80,425	11	64,979	98,431
August 2011	107,744	10	87,880	130,749
September 2011	98,216	9	81,297	117,608
October 2011	102,327	9	85,561	121,409
November 2011	113,278	10	93,452	136,055
December 2011	113,036	10	93,048	136,035
January 2012	116,160	12	90,966	146,176
February 2012	79,003	10	64,242	96,133
March 2012	130,007	11	103,667	160,995
April 2012	79,499	11	64,393	97,078
May 2012	62,039	10	50,648	75,222
June 2012	90,545	10	74,311	109,263
July 2012	74,066	10	60,971	89,133
August 2012	89,532	10	73,482	108,037
September 2012	74,593	10	60,481	91,004
October 2012	91,063	12	71,831	113,861

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
		Total Phosphorus		
October 2010	13,884	12	10,978	17,324
November 2010	13,785	12	10,868	17,243
December 2010	14,846	12	11,689	18,594
January 2011	11,199	14	8,507	14,474
February 2011	7,076	12	5,553	8,889
March 2011	9,810	12	7,769	12,223
April 2011	9,220	12	7,199	11,633
May 2011	11,873	12	9,324	14,903
June 2011	6,172	12	4,842	7,754
July 2011	9,587	12	7,577	11,968
August 2011	13,828	12	10,960	17,218
September 2011	12,590	11	10,007	15,636
October 2011	12,362	11	9,840	15,334
November 2011	12,155	12	9,537	15,270
December 2011	10,861	12	8,566	13,581
January 2012	9,806	13	7,487	12,617
February 2012	6,848	12	5,375	8,599
March 2012	11,001	12	8,641	13,806
April 2012	7,530	12	5,918	9,447
May 2012	6,677	12	5,237	8,390
June 2012	11,181	12	8,805	14,000
July 2012	10,367	12	8,191	12,944
August 2012	13,432	12	10,654	16,713
September 2012	11,190	11	8,909	13,876
October 2012	12,772	11	10,149	15,865

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
		Orthophosphate		
October 2010	1,817	27	29	1,036
November 2010	2,046	27	33	1,164
December 2010	2,529	28	37	1,426
January 2011	2,610	39	51	1,166
February 2011	1,184	29	37	657
March 2011	1,672	29	37	919
April 2011	1,591	34	37	780
May 2011	1,655	30	31	888
June 2011	621	28	22	351
July 2011	962	27	22	549
August 2011	1,424	26	22	827
September 2011	1,417	26	24	822
October 2011	1,571	26	29	913
November 2011	1,925	30	35	1,027
December 2011	1,843	29	37	1,023
January 2012	2,156	36	49	1,021
February 2012	1,091	28	35	617
March 2012	2,094	32	42	1,080
April 2012	1,102	30	33	591
May 2012	797	28	26	445
June 2012	1,225	27	24	699
July 2012	1,035	27	22	595
August 2012	1,374	26	22	802
September 2012	1,237	26	24	721
October 2012	1,659	27	29	955

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
Total Suspended solids				
October 2010	4,055,701	27	2,327,577	6,586,403
November 2010	4,202,219	27	2,396,521	6,857,108
December 2010	4,408,900	27	2,509,659	7,204,664
January 2011	2,847,124	30	1,519,242	4,882,728
February 2011	1,719,226	28	970,376	2,827,488
March 2011	2,083,092	27	1,205,764	3,360,899
April 2011	1,741,745	28	982,581	2,865,634
May 2011	2,197,509	27	1,249,326	3,594,373
June 2011	1,211,523	28	681,873	1,996,791
July 2011	2,032,789	27	1,166,540	3,301,402
August 2011	3,330,809	27	1,923,713	5,383,109
September 2011	3,414,394	26	1,982,287	5,496,253
October 2011	3,639,310	26	2,121,434	5,840,166
November 2011	3,640,749	28	2,060,996	5,974,354
December 2011	3,178,061	27	1,819,101	5,171,480
January 2012	2,508,012	30	1,347,423	4,279,649
February 2012	1,677,291	28	946,967	2,757,946
March 2012	2,259,594	27	1,295,131	3,673,122
April 2012	1,458,689	27	829,275	2,385,953
May 2012	1,272,578	28	715,478	2,099,094
June 2012	2,190,552	27	1,246,878	3,579,710
July 2012	2,214,911	27	1,268,815	3,602,010
August 2012	3,245,319	27	1,877,628	5,237,918
September 2012	3,023,287	26	1,762,748	4,850,744
October 2012	3,769,608	26	2,188,658	6,067,747

Table F4. Estimates and error analysis for monthly loads determined from LOADEST model for Lake River at Felida flowing OUT, 14211955, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
		Total nitrogen		
October 2010	121,002	10	99,171	146,199
November 2010	127,664	10	103,757	155,418
December 2010	139,133	11	111,905	170,975
January 2011	143,017	12	112,345	179,483
February 2011	114,940	11	92,261	141,499
March 2011	88,165	11	70,436	108,996
April 2011	87,505	11	70,341	107,587
May 2011	64,697	11	51,392	80,392
June 2011	94,488	11	75,278	117,101
July 2011	111,707	11	88,884	138,598
August 2011	109,078	10	88,402	133,131
September 2011	109,019	10	89,582	131,412
October 2011	123,301	10	101,154	148,845
November 2011	123,314	10	99,941	150,501
December 2011	118,528	11	94,877	146,279
January 2012	135,609	11	109,124	166,572
February 2012	106,423	11	85,130	131,421
March 2012	83,887	11	66,951	103,800
April 2012	91,275	11	73,605	111,901
May 2012	96,909	11	77,578	119,589
June 2012	81,240	11	64,610	100,841
July 2012	107,154	11	85,696	132,348
August 2012	111,330	11	90,089	136,066
September 2012	107,336	10	88,214	129,362
October 2012	110,447	10	90,045	134,081

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
		Total Phosphorus		
October 2010	12,648	13	9,658	16,274
November 2010	11,058	14	8,353	14,362
December 2010	10,220	15	7,617	13,430
January 2011	9,556	16	6,913	12,881
February 2011	7,833	15	5,802	10,346
March 2011	6,187	15	4,550	8,224
April 2011	7,260	15	5,392	9,569
May 2011	6,460	16	4,683	8,692
June 2011	12,062	15	8,819	16,113
July 2011	16,167	15	11,825	21,588
August 2011	15,639	14	11,736	20,428
September 2011	13,796	13	10,559	17,714
October 2011	13,042	13	9,971	16,763
November 2011	10,549	14	7,949	13,731
December 2011	8,394	15	6,225	11,075
January 2012	9,162	15	6,822	12,049
February 2012	7,052	15	5,204	9,346
March 2012	5,923	15	4,347	7,885
April 2012	7,586	15	5,652	9,970
May 2012	10,210	15	7,501	13,583
June 2012	10,199	16	7,418	13,684
July 2012	15,337	15	11,279	20,387
August 2012	16,048	14	12,016	21,003
September 2012	13,495	13	10,329	17,327
October 2012	11,203	14	8,505	14,488

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
		Orthophosphate		
October 2010	4,719	47	1,781	10,243
November 2010	3,502	40	1,543	6,870
December 2010	3,024	34	1,486	5,503
January 2011	2,796	32	1,435	4,936
February 2011	1,679	27	972	2,709
March 2011	1,074	26	635	1,709
April 2011	1,379	26	800	2,220
May 2011	847	27	489	1,367
June 2011	1,682	26	992	2,676
July 2011	2,040	26	1,202	3,247
August 2011	1,559	25	933	2,452
September 2011	1,201	25	725	1,876
October 2011	1,053	25	633	1,653
November 2011	832	26	487	1,332
December 2011	623	28	353	1,021
January 2012	833	27	474	1,362
February 2012	576	28	322	952
March 2012	512	28	289	842
April 2012	828	27	478	1,336
May 2012	1,249	27	723	2,017
June 2012	1,098	26	642	1,757
July 2012	2,037	27	1,179	3,285
August 2012	2,061	26	1,215	3,283
September 2012	1,793	26	1,052	2,868
October 2012	1,602	29	880	2,687

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
Total Suspended Solids				
October 2010	3,524,013	15	2,610,577	4,654,649
November 2010	2,970,560	15	2,174,213	3,964,393
December 2010	2,392,745	16	1,731,722	3,224,016
January 2011	1,828,126	17	1,294,581	2,509,040
February 2011	1,579,275	16	1,130,945	2,147,131
March 2011	1,226,755	17	869,161	1,682,967
April 2011	1,242,888	16	893,437	1,684,368
May 2011	1,312,121	18	916,563	1,821,598
June 2011	2,342,760	17	1,646,216	3,236,342
July 2011	3,393,391	17	2,398,821	4,664,162
August 2011	3,917,638	16	2,850,735	5,254,408
September 2011	3,773,186	15	2,804,141	4,970,028
October 2011	3,645,701	15	2,704,268	4,809,946
November 2011	2,821,299	16	2,059,877	3,773,142
December 2011	2,161,787	16	1,550,010	2,936,018
January 2012	1,920,757	16	1,387,579	2,592,092
February 2012	1,493,792	17	1,064,128	2,039,939
March 2012	1,170,574	17	827,812	1,608,411
April 2012	1,325,381	16	951,928	1,797,455
May 2012	1,752,312	17	1,246,512	2,395,856
June 2012	2,152,185	18	1,508,139	2,979,956
July 2012	3,214,869	17	2,292,158	4,387,044
August 2012	4,003,602	16	2,905,839	5,381,429
September 2012	3,706,168	15	2,754,008	4,882,252
October 2012	3,186,987	15	2,345,287	4,233,555

Table F5. Estimates and error analysis for monthly loads determined from LOADEST model for Salmon Creek at Lake River, 14213050, Vancouver, Washington, October 2010–October 2012.

[**Abbreviations:** LOADEST, LOAD ESTimation program]

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
		Total nitrogen		
October 2010	21,224	13	16,362	27,080
November 2010	90,218	19	61,192	128,347
December 2010	135,253	16	98,141	181,841
January 2011	123,208	11	98,075	152,813
February 2011	59,212	13	45,233	76,154
March 2011	110,404	10	89,936	134,129
April 2011	76,144	10	61,844	92,755
May 2011	39,300	10	31,838	47,983
June 2011	15,696	10	12,720	19,157
July 2011	9,766	10	7,932	11,896
August 2011	7,123	10	5,781	8,682
September 2011	7,822	11	6,313	9,583
October 2011	13,115	11	10,539	16,129
November 2011	58,729	17	41,741	80,356
December 2011	49,926	12	39,548	62,193
January 2012	108,950	11	87,129	134,569
February 2012	78,741	12	62,353	98,114
March 2012	114,802	10	93,421	139,604
April 2012	66,403	10	53,930	80,892
May 2012	35,177	11	28,484	42,967
June 2012	26,217	12	20,457	33,096
July 2012	12,385	11	9,955	15,227
August 2012	7,708	10	6,262	9,389
September 2012	7,200	11	5,795	8,843
October 2012	24,397	15	17,957	32,405

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
		Total Phosphorus		
October 2010	1,068	9	885	1,278
November 2010	4,299	11	3,457	5,284
December 2010	6,868	13	5,284	8,778
January 2011	5,843	12	4,550	7,391
February 2011	2,363	11	1,904	2,900
March 2011	6,174	11	4,910	7,662
April 2011	4,667	11	3,767	5,718
May 2011	2,384	11	1,920	2,926
June 2011	1,064	10	864	1,297
July 2011	813	10	667	982
August 2011	699	13	534	900
September 2011	675	14	509	877
October 2011	782	10	635	952
November 2011	2,878	12	2,271	3,596
December 2011	2,005	11	1,619	2,455
January 2012	5,121	12	3,990	6,474
February 2012	3,462	11	2,794	4,242
March 2012	6,923	12	5,384	8,765
April 2012	3,941	11	3,183	4,826
May 2012	2,158	11	1,744	2,642
June 2012	1,714	11	1,372	2,115
July 2012	933	10	768	1,123
August 2012	717	12	560	904
September 2012	659	15	486	874
October 2012	1,272	10	1,049	1,529

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
		Orthophosphate		
October 2010	658	18	452	926
November 2010	2,603	27	1,477	4,264
December 2010	3,269	23	2,048	4,960
January 2011	2,379	17	1,711	3,221
February 2011	917	19	622	1,305
March 2011	1,602	15	1,193	2,105
April 2011	1,092	15	811	1,442
May 2011	616	15	454	816
June 2011	288	15	214	381
July 2011	222	15	165	293
August 2011	194	15	143	256
September 2011	238	15	174	317
October 2011	401	15	293	536
November 2011	1,646	25	1,001	2,553
December 2011	1,149	17	822	1,561
January 2012	2,062	17	1,497	2,773
February 2012	1,229	16	880	1,673
March 2012	1,660	15	1,235	2,185
April 2012	947	15	703	1,250
May 2012	549	15	406	728
June 2012	497	17	348	688
July 2012	282	15	207	377
August 2012	211	15	157	278
September 2012	218	15	159	291
October 2012	758	21	485	1,131

	Load (pounds)	Percentage Error	Lower 95 percent prediction interval (pounds)	Upper 95 percent prediction interval (pounds)
Total Suspended Solids				
October 2010	94,072	26	55,324	149,939
November 2010	489,857	33	247,111	875,097
December 2010	959,899	40	418,544	1,897,348
January 2011	782,828	40	338,213	1,556,903
February 2011	218,572	31	115,864	376,667
March 2011	767,009	33	387,423	1,368,940
April 2011	523,333	31	277,875	900,772
May 2011	208,204	30	111,760	355,507
June 2011	84,346	29	46,902	140,286
July 2011	74,138	27	42,197	121,159
August 2011	76,891	37	35,981	144,833
September 2011	75,821	39	33,729	147,859
October 2011	74,647	29	41,299	124,626
November 2011	346,314	40	151,506	683,001
December 2011	202,292	34	99,165	368,837
January 2012	679,298	41	288,428	1,366,722
February 2012	370,562	32	191,865	649,655
March 2012	937,137	38	429,601	1,790,440
April 2012	431,272	31	225,167	751,523
May 2012	190,169	30	102,402	323,956
June 2012	138,157	31	73,652	237,100
July 2012	78,782	27	45,423	127,490
August 2012	75,583	34	37,640	136,273
September 2012	76,602	42	32,374	154,597
October 2012	121,551	28	68,894	199,275

Appendix G. Porewater Nutrient Data from Vancouver Lake, Washington, October 2010–October 2012

Appendix G tables are Microsoft® Excel files and can be downloaded from *http://pubs.usgs.gov/sir/2014/5201*.

Table G1. Nutrient concentrations in porewater collected from Lake Sites 1 and 2, Vancouver Lake, Vancouver, Washington, August 2011.

Table G2. Nutrient concentrations in porewater collected from Lake Sites 1 and 2, Vancouver Lake, Vancouver, Washington, August 2012.