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NUTRIENT COMPOSITION and BIOAVAILABILITY in MAJOR TRIBUTARIES and INTERCONNECTING RIVERS of the OKANAGAN BASIN

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ABSTRACT

The biological availability of phosphorus and nitrogen in rivers and streams of the Okanagan Basin was evaluated by chemical analysis of water and suspended sediments. Biologically available phosphorus (BAP) was defined as the sum of dissolved P and the fraction of particulate P which was not apatite. Biologically available nitrogen (BAN) was defined as the sum of dissolved inorganic N, particulate N and half of the dissolved organic N. BAP content of the annual loadings varied from 16 to 98% of TP while BAN varied from 58 to 98% of TN. The highly variable quantity and quality of particulate P was responsible for the large range of BAP content. On the other hand, much lower variability and dominance of dissolved organic N was responsible for the smaller range of BAN content. Availability tended to be higher in streams with cultural inputs, especially in the case of nitrogen. Full utilization of BAP and BAN loadings probably depends on the length of time that these materials remain in the biologically active zones in each of the Okanagan Valley lakes.

RÉSUMÉ

La disponibilité biologique de phosphore et d'azote dans les rivières et les ruisseaux du Bassin de l'Okanagane fut évaluée par l'analyse chimique des eaux et des solides en suspension. La disponibilité biologique de phosphore (BAP) fut définie comme la somme de P dissout et la fraction du P particulaire qui n'est pas sous forme d'apatite. Aussi la disponibilité biologique d'azote (BAN) fut définie comme la somme de N inorganique dissout, de N particulaire et la moitié de N organique dissout. Pour BAP le contenu du chargement annuel varait entre 16 à 98% du TP quand à BAN elle varait de 58% à 98% du TN. La grande variation de P particulaire en quantité et qualité fut responsable pour le grand écart du contenu de BAP. Par contre, le N organique dissout qui était dominant et beaucoup moins variable, fut responsable pour le petit écart du contenu BAN. La disponibilité de ses substances avait tendance d'être plus élevé, spécialement pour l'azote, dans des ruisseaux qui recevaient des substances nutritives anthropogénique. L'utilisation complète des chargements de BAP et de BAN dépend probablement de la variabilité du temps que ces matériaux sont dans la zone active biologique des lacs de l'Okanagane.

Table of Contents

Abstract

Resumé

Table of Contents

List of Figures

List of Tables

Acknowledgements

1. Introduction	1
2. Methods	6
2.1 Water sampling and analysis	6
2.2 Suspended sediment sampling and analysis	7
3. Data	11
3.1 Sampling site characteristics	11
3.2 Sampling dates	11
3.3 Water sampling results	16
3.3.1 Compositional and seasonal pattern	16
3.3.2 Relationships of PP and PN to turbidity	21
3.4 Suspended sediment sampling results	27
4. Discussion	33
4.1 Definition and Computation of BAP and BAN	33
4.2 Relative BAP and BAN loadings	40
5. Conclusions	44
References	48
Appendix I: Data	
Appendix II: BAP and BAN Loadings	
Appendix III: Estimate of areal nutrient yield from natural runoff	

List of Figures

1. Map of the Okanagan Drainage Basin and station locations	12
2. Mission and Deep Creeks phosphorus concentrations	17
3. Skaha Lake outlet and inlet phosphorus concentration	19
4. Lambly Creek nitrogen concentrations	20
5. Coldstream Creek nitrogen concentrations	22
6. Skaha Lake outlet nitrogen concentrations	23
7. PP and PN versus turbidity in mountain tributaries	24
8. PP and PN versus turbidity in lake inlets	25
9. PP and PN versus turbidity in lake outlets	26
10. Frequency of TP, NAIP, OP and AP concentrations in 17 suspended sediment samples	29

List of Tables

1.	Phosphorus and nitrogen analysis scheme	3
2.	Chemical analysis procedures	8
3.	Station locations	13
4.	Water sampling dates	14
5.	Suspended sediment sampling stations and dates	15
6.	Suspended sediment phosphorus component concentrations ($\mu\text{g}\cdot\text{g}^{-1}$)	28
7.	Comparsion of P components in suspended sediments collected in Shingle Creek drainage basin on April 30 and May 25	32
8.	Particulate P bioavailability coefficients	37
9.	Comparison of inflow and outlet concentrations of DON ($\mu\text{g}\cdot\text{L}^{-1}$)	39
10.	10 year discharge - averaged BAP and BAN loadings as a percent of TP and TN loadings	43

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1. INTRODUCTION

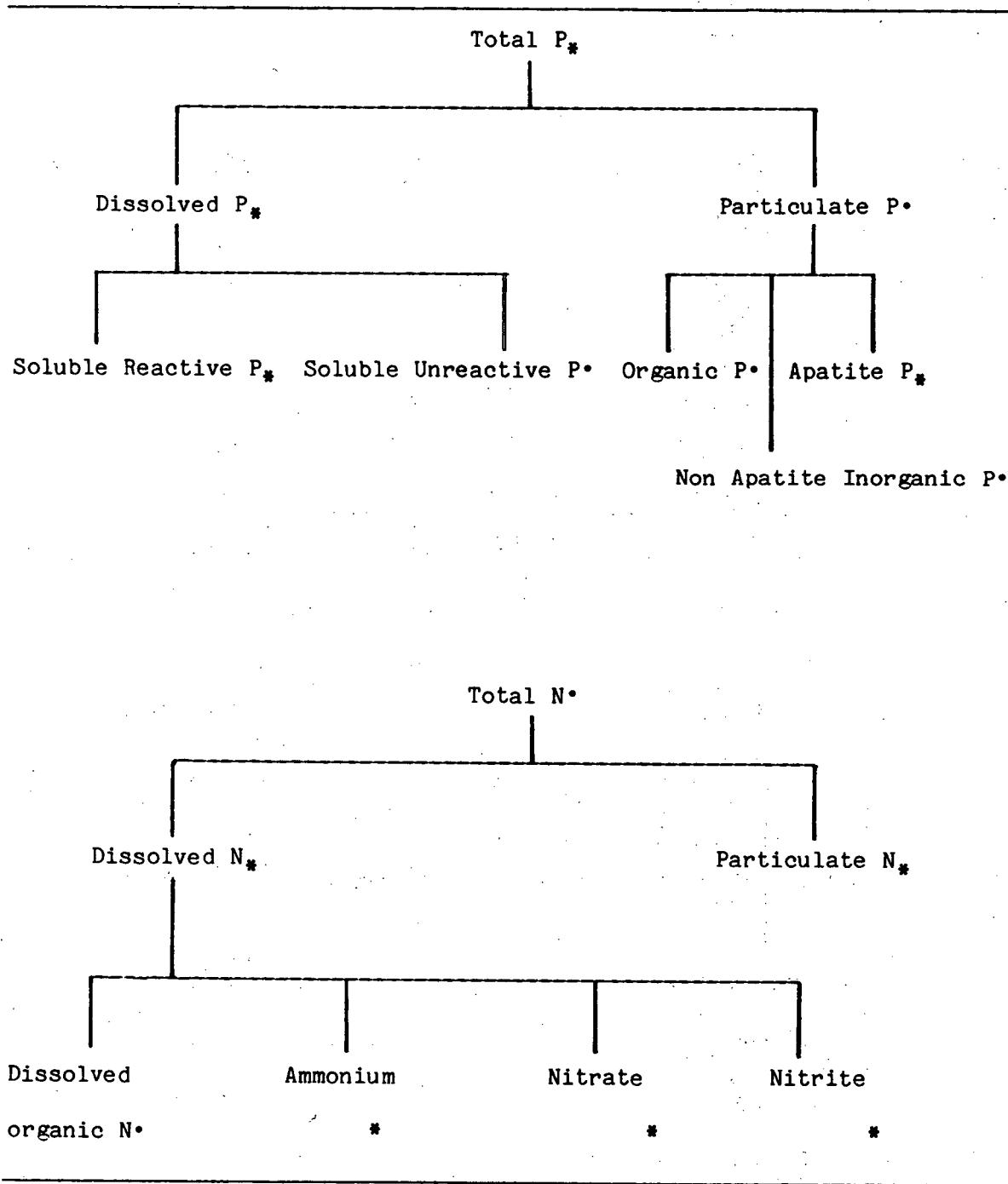
The impact of nutrient loading on the trophic state of the five major Okanagan lakes has been evaluated using analyses of total nitrogen (TN) and phosphorus (TP) in tributaries and in effluents from sewage treatment plants (Tech. Supp. V, Canada-British Columbia Okanagan Basin Study, 1974; Stockner and Northcote, 1974). It has been recognized for several years, however, that biologically available N and P loadings are usually less than TN or TP loading (Oglesby, 1977; Depinto et al., 1981). Since the biological availability of particulate P was found to be highly variable in these studies and a large portion of the loading in the Okanagan Basin was particulate, there was concern that the TP loadings were a significant overestimate of biologically available P. This was found to be the case for Kamloops Lake in the next drainage basin to the north (St. John et al., 1976). Because of the foregoing concerns, the Okanagan Basin Implementation Board (OBIB) requested that NWRI investigate the biological availability of the nutrient loadings transported to the Okanagan lakes by surface water streams and rivers.

Biological availability of nutrients in water or suspended sediments can be assessed by measuring it in a bioassay or by estimating it with chemical measurements of components of known availability. Chemical

measurements were used in this study because it could be initiated with the least amount of laboratory preparation considering the short time allotted for providing the information to the OBIB. This objective was approached by sampling the tributaries six times during the year long study for the analyses of total P, dissolved P, soluble reactive P (SRP), dissolved N, ammonium N, nitrite N, nitrate N, and particulate N (PN). These analyses allowed the calculation of particulate P (PP), soluble unreactive P (SUP), total N, dissolved organic N (DON), and dissolved inorganic N (DIN) (Table 1). The forms of P in the particulate fraction were estimated by methods similar to Williams et al. (1976) on samples of suspended sediments collected during the spring "freshet" by continuous flow centrifugation (Ongley and Blachford, 1982). The phosphorus components in this particulate material is reported as apatite P (AP), non-apatite inorganic P (NAIP), and organic P (OP).

Biological availability depends on the form of the N or P and on the time of exposure of the form to the biological system. The most important availability consideration for lake management is whether or not a component can be utilized by the phytoplankton, the primary producers of the lake. These organisms can utilize directly only a small number of molecular forms of N and P; namely orthophosphate, nitrate, nitrite, and ammonium. The uptake of other forms of N and P require their prior transformation by chemical or biochemical processes to these four compounds. Hence the term "availability" is in practice defined arbitrarily by the investigator because the rates of transformation for each component is dependent on its form and the mix of chemical and

Table 1: Phosphorus and nitrogen analysis scheme



* measured components

• calculated components

biochemical processes occurring in that particular receiving environment. The definition of "availability" used in this study is elaborated in the discussion.

Estimating the relative proportion of biologically available P and N (BAP and BAN) in the total P and N loadings requires sampling throughout the year because the relationship between BAP and TP or BAN and TN is variable. An adequate sampling frequency for observing compositional changes was assumed to be much lower than that required for annual loading estimates. In this study six samples per year were assumed to be adequate to describe the compositional changes which occur seasonally. The composition was expected to be affected strongly by hydrology. Specifically, the particulate P was expected to be the major component of TP during spring runoff. Hence it was additionally assumed that one sample of the suspended sediment collected during the high flow period would be adequate to characterize the bioavailability of the PP loading at each site.

The sampling occurred between September, 1980 and August, 1981. The sampling periods were almost equally distributed between high and low flow. The high flow periods sampled in this study were during spring runoff as significant rain storm events in other seasons were missed. The stream discharges during low flow period preceding the 1981 snow melt were below average but the discharges during the snow melt were higher than normal. This discharge pattern was caused by double the normal rainfall in May on a less than average snowpack. The discharges during

June and July were average except for discharges at the Okanagan River sites which were well above average.

2. METHODS

2.1. Water Sampling and Analysis

Water samples were retrieved from the point of obvious main flow on the smaller creeks and from central positions below bridges, if available, on larger rivers. In larger creeks or rivers without bridges, the samples were obtained close to shore where no obvious back eddies occurred. Since ascertaining spatial and temporal variabilities was not the objective of this study, only one sample was collected and then analyzed in triplicate. The sample was collected by plastic bucket and immediately poured into 3 one litre plastic bottles in a way that maintained homogeneity. These 3 bottles then became the replicates for chemical analyses.

Turbidity, conductivity and temperature were measured on the sample in the field. Turbidity was measured with a DTR 2000 meter in NTU units, conductivity was measured with an induction probe on a Triac CM100 and temperature with a mercury thermometer graduated in 0.1°C.

For analysis of dissolved N and P components samples were filtered immediately through Satorius cellulose acetate membrane filters (0.45 micron, SM 11106) which had been soaked in deionized water for 8 hours. SRP samples (50mL) were preserved with 0.5mL of chloroform. All samples were stored in coolers. The PC/PN samples were filtered at the end of the day through Whatman GF/F glass fiber filters and frozen.

SRP samples were analyzed at the NWRI laboratory within a week of collection. All remaining chemical analysis were conducted at the Pacific Water Quality Laboratory within a week of sampling. The analytical procedures are outlined in Table 2.

2.2. Suspended Sediment Sampling and Analysis

Suspended sediments were collected by continuous-flow centrifugation of water simultaneously pumped from the middle of the stream. The configuration of the sampling apparatus and technique was designed and supplied by ENVIRODATA Ltd., who were contracted for the sampling. Their SediSamp System I is fully described by Ongley and Blachford (1982). The flow-through rate was $4\text{L}\cdot\text{min}^{-1}$. Because the content of suspended sediments varied considerably, the sampling interval varied from 45 minutes to 6 hours. After enough sediment had been collected, the sediments were transferred with washing to a plastic bottle. This sample was concentrated at the end of the day in a batch centrifuge and transferred to plastic bags and frozen. Upon return to the laboratory, the samples were freeze dried and sieved through a 64 micron sieve. Only the finer size-fraction was analyzed for phosphorus components.

The P fraction analysis scheme was essentially a modification of the proximate analysis technique developed by Williams et al. (1976). It involved the analysis of orthophosphate in 3 different extracts of the sediment samples. For total P (TP), a sub-sample was roasted at 550°C for 2 hours and extracted twice for 16 hours in 1N HCl.

TABLE 2: Chemical Analysis Procedures

Analysis	Range	Detection Limit
1. Phosphorous (total and dissolved): Sulphuric acid and persulphate digestion in an autoclave followed by formation of the coloured complex of antimony-phospho- molybdate after reduction with ascorbic acid. Measured at 880 nm	0-50 ppb	0.5 ppb
	0-200 ppb	2 ppb
2. Phosphorus (soluble reactive): Phosphomolybdate complex formed on an undigested sample and reduced to the coloured complex with Sn Cl_2 . Measured at 660 nm.	0.50 ppb	1 ppb
3. Nitrate + Nitrite: Nitrate reduced to nitrite using a Cu coated Cd filing column. Azo dye formed with sulphanilamide and N-(1 naphthyl) ethyl ethylenediamine dihydrochloride. Measured at 550 nm	0-200 ppb	2 ppb
4. Ammonia: Formation of indophenol by reaction with hypochlorite, phenol and nitroprusside. Measured at 630 nm	0-200 ppb	2 ppb

TABLE 2: Analysis Procedures continued

Analysis Procedure	Range	Detection Limit
5. Total Dissolved N: Oxidation by UV light under acidic then basic conditions to nitrate and nitrite. Measured as in procedure 3.	0-500 ppb	10 ppb
6. PC/PN: Filtration on 47 mm GF/F glass fiber filters which have been ashed at 450°C for four hours. Filters frozen in the field and air dried before analysis on a Hewlett-Packard CHN analyzer after com- bustion at 950°C.	5-1000 ppb	5 ppb if 1 L filt- ered
7. Silica: Formation of the silicomolybdate complex and subsequent destruction of the phosphomolybdate complex with oxalic acid. Measured at 480 nm.	0-20 ppm	0.2 ppm
8. Chloride: Formation of ferric thiocyanate after reaction with mercuric thiocyanate. Measured at 480 nm.	0-20 ppm	0.2 ppm

For total inorganic P (TIP), a second sub-sample was extracted in 1N HCl without prior roasting. For apatite P (AP), a third sub-sample was sequentially extracted with citrate dithionite buffer for 30 minutes, 1N NaOH for 16 hours and 1N HCl for 16 hours. Only the HCl extract was analyzed. The extracts were analyzed spectrophotometrically in a Technicon System after a 15:1 dilution after the methods of Harwood et al. (1969) using ascorbic acid as the reductant.

Organic P (OP) was calculated by subtracting TIP from TP. Non-apatite inorganic P (NAIP) was calculated by subtracting AP from TIP.

3. DATA

3.1. Sampling site characteristics

There were 20 sampling locations which were categorized into two groups based on the source of their water (Figure 1). Mountain tributaries have their sources predominantly at higher elevations in the drainage basin, and valley tributaries have their sources in the major valley lakes (Table 3). Additional sampling was undertaken at upstream sites in the Shingle and Vaseux Creeks drainage basins in support of activities of the OBIB study on nutrient loadings. These locations were sampled during October, 1980 and early May, 1981 for water analyses and in early May for suspended sediments.

Most streams were sampled as near as possible to their mid-point of flow. Exceptions were the outlets of Wood, Kalamalka, Okanagan and Skaha Lakes, and some tributaries during highest flows when wading into the middle of the creek bed would have been suicidal. These exceptions were sampled at the shore in the obvious downstream flow. It was assumed that the potential cross-stream variability in content of N and P would not affect the relative composition significantly.

3.2 Sampling Dates:

The sampling occurred during seven trips to the valley (Table 4). Some stations were not sampled on each trip. Specific dates and hour of sampling are included in the data listings (Appendix I).

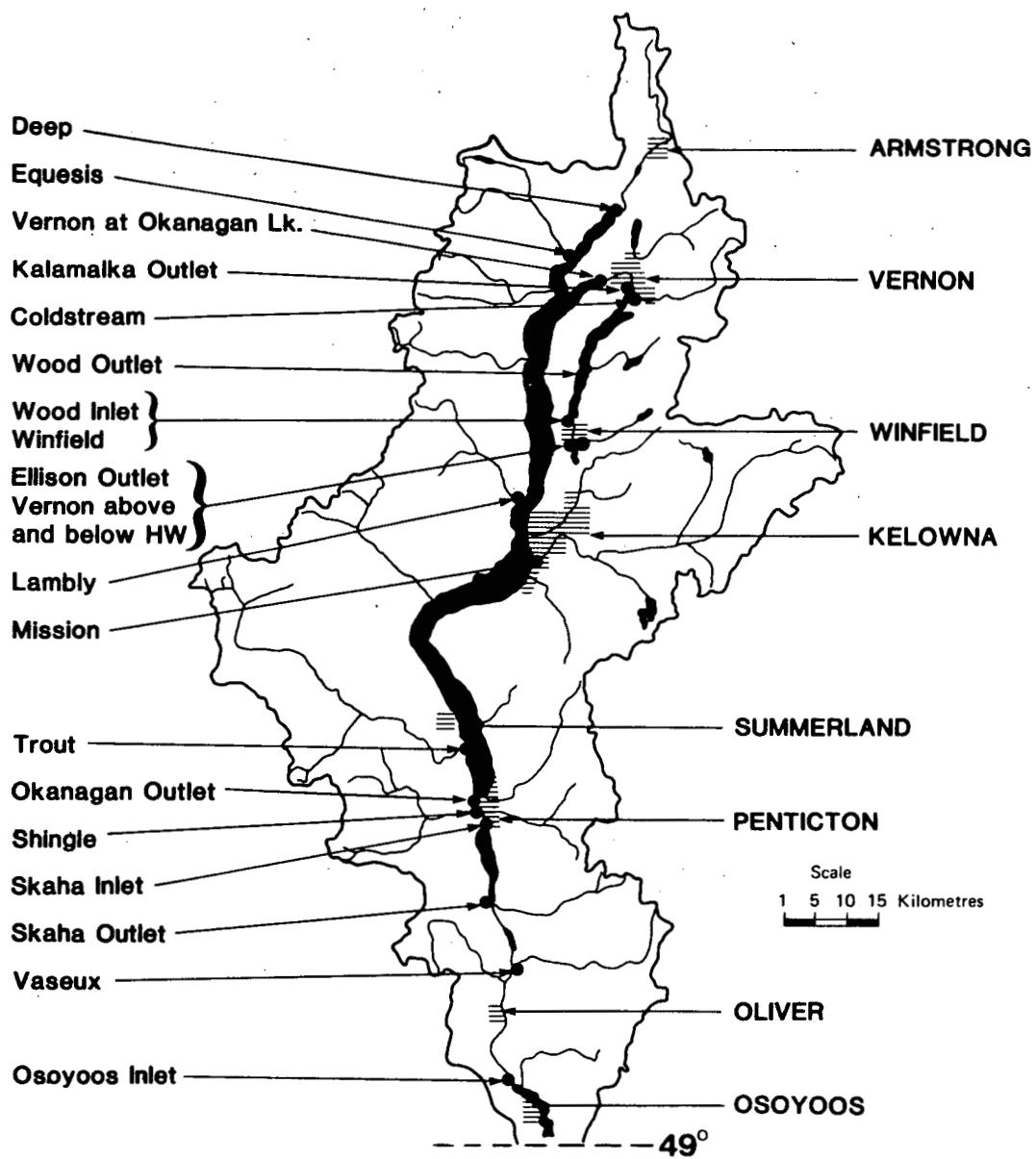


FIGURE 1: Map of the Okanagan Drainage Basin and station locations

TABLE 3: Station Locations

Categories	Location	
	N	W
1. Mountain Tributaries		
Deep	50.20.58	119.17.50
Equesis	50.17.18	119.24.38
Coldstream	50.13.28	119.15.30
Vernon above Hiram Walker	50.00.50	119.23.00
Vernon below Hiram Walker	50.00.13	119.23.16
Winfield	50.03.08	119.24.18
Mission	49.50.34	119.29.10
Lambly	49.55.42	119.30.40
Trout	49.34.05	119.37.50
Shingle	49.28.48	119.36.03
Vaseux	49.14.42	119.31.25
2. Valley Tributaries		
a) Lake inlets		
Vernon at Wood	50.03.08	119.24.15
Vernon at Okanagan	50.15.50	119.20.35
Okanagan at Skaha	49.27.20	119.35.45
Okanagan at Osoyoos	49.05.21	119.32.05
b) Lake outlets		
Ellison	50.00.58	119.24.05
Wood	50.06.39	119.22.50
Kalamalka	50.13.54	119.16.00
Okanagan	49.30.06	119.36.45
Skaha	49.20.40	119.34.48

preliminary sampling was carried out in late May 1980 in Vernon, Equestis and Coldstream Creeks. The results of this sampling were used in the analysis.

TABLE 4: Water Sampling Dates

Monitor #	Year	Month	Days	Stations not sampled
1	80	Sept	8-11	Winfield, Shingle
2a	80	Oct	19-20	Lambly; Trout; Vernon below-HW; Vaseux; Equestis; Okanagan, Ellison, Skaha and Kalamalka outlets; Skaha and Osoyoos inlets
2b	80	Dec	2	every one except Vernon at Wood, Wood outlet, Winfield
3	81	Jan	20-22	
4	81	Apr May	30 1-6	Vernon below HW
5	81	May	26-28	
6	81	June	23-25	
7	81	July	27-30	

Monitors 4 and 5 were during the spring snow melt with monitor 5 experiencing the highest flows. High flows persisted in some stations during monitor 6. This was the case in the Okanagan River and in Vernon, Deep, Coldstream and Trout Creeks. No major rainstorm events occurred during the other monitors so the

TABLE 5: Suspended Sediment Stations and Sampling Duration

Location	Date (1981)	Time
<u>Mountain Tributaries</u>		
Deep	May 3	0940-1040
Equesis	May 3	0900-1100
Coldstream	May 3	1355-1505
Vernon above Hiram-Walker	May 4	1026-1326
Mission	May 2	1120-1305
Lambly	May 2	1033-1203
Trout	April 30	0946-1030
Shingle at Mouth	April 30	1645-1830
Shingle below Rogers Ranch ₁	April 30	1440-1540
Shatford at bridge ₁	April 30	1404-1628
Vaseux	May 1	1637-1822
Vaseux at hydrometric station ₂	May 5	1126-1225 1323-1640
Underdown Creek ₂	May 5	1325-1710
Wabash Creek ₂	May 1	1148-1445
Upper Vaseux ₂	May 1	1105-1410
<u>Lake Inlets</u>		
Vernon at Wood Lake	May 4	0926-1026
Vernon at Okanagan Lake	May 3	1205-1435

1. Stations in the Shingle Creek drainage basin
2. Stations in the Vaseux Creek Drainage basin

concentrations on those dates were considered to represent low flow.

Suspended sediment sampling took place from April 30 to May 5 during monitor 4. All lake outlets and the inlets of Skaha and Osoyoos Lakes were not sampled for suspended sediments. Stations sampled and duration of sampling is listed in Table 5.

3.3. Water Sampling Results

3.3.1. Compositional and seasonal pattern

There were basic differences in compositional and seasonal patterns between the mountain and valley tributaries. The seasonal effects on P concentrations were dramatic in both types. The compositional patterns were modified to varying degrees when significant cultural sources of N and P existed. To facilitate the description, phosphorus and nitrogen will be treated separately. Complete data are available in Appendix I.

Phosphorus

In most mountain tributaries, the concentrations of SUP, SRP and PP fluctuated within a narrow range except during the spring snow melt (Monitors 4, 5 and 6) when concentrations of SUP and PP increased dramatically. Mission Creek showed this pattern (Figure 2). However, in tributaries with large cultural inputs, SUP was constant and SRP decreased during the freshet (eg. Deep, Figure 2).

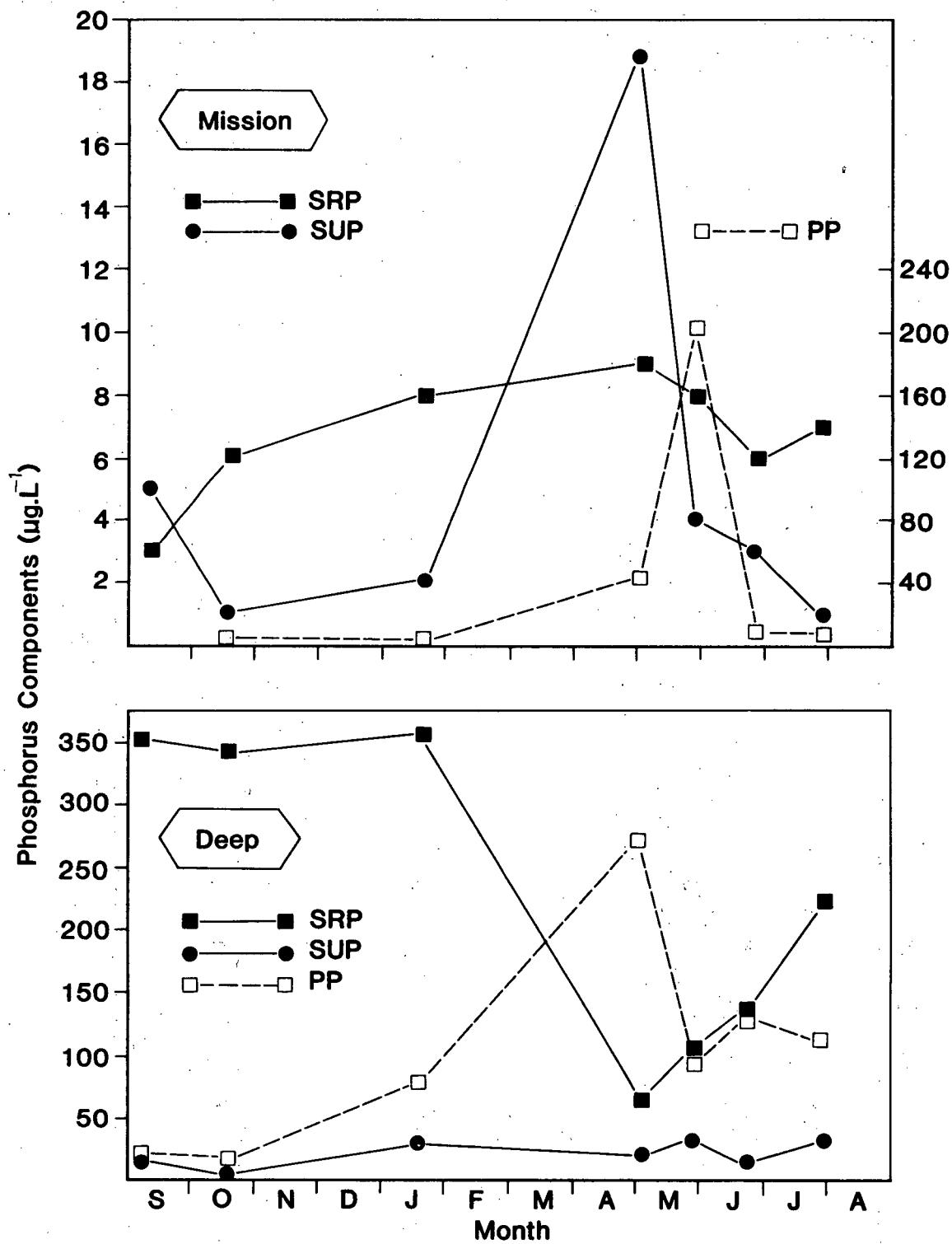


FIGURE 2: Mission and Deep Creeks phosphorus concentrations

At most lake inlet stations, the PP was highest during spring freshet whereas SRP and SUP generally declined. This pattern was demonstrated at the inlet of Skaha (Figure 3). The very high PP observed in late May reflects the influence of Shingle and Ellis creeks at this time of year when they carried large amounts of PP to the Okanagan River. The surprisingly high SRP and SUP in early May reflects the influence of the Penticton sewage treatment plant effluent at a time when the outflow from Okanagan Lake was very low ($2.9 \text{ m}^3 \cdot \text{s}^{-1}$). Effects similar to these were observed at the other lake inlet stations.

At most lake outlet stations (eg. Skaha Lk., Figure 3), high SUP and SRP concentrations occurred in winter and early spring followed by low concentrations in summer. Two exceptions were the outlets of Kalamalka and Ellison lakes where concentrations were highest in July and September respectively. PP was generally higher during the summer in lake outlets although this was not the case for Skaha.

Nitrogen

In mountain tributaries, DON was usually the dominant form of N and usually reached maximum concentrations during the spring freshet (eg. Lambly, Figure 4). In contrast nitrate + nitrite (NN) and ammonium (AN) were usually highest during winter. However, this generalization did not describe the pattern observed in tributaries with cultural inputs (eg. Winfield,

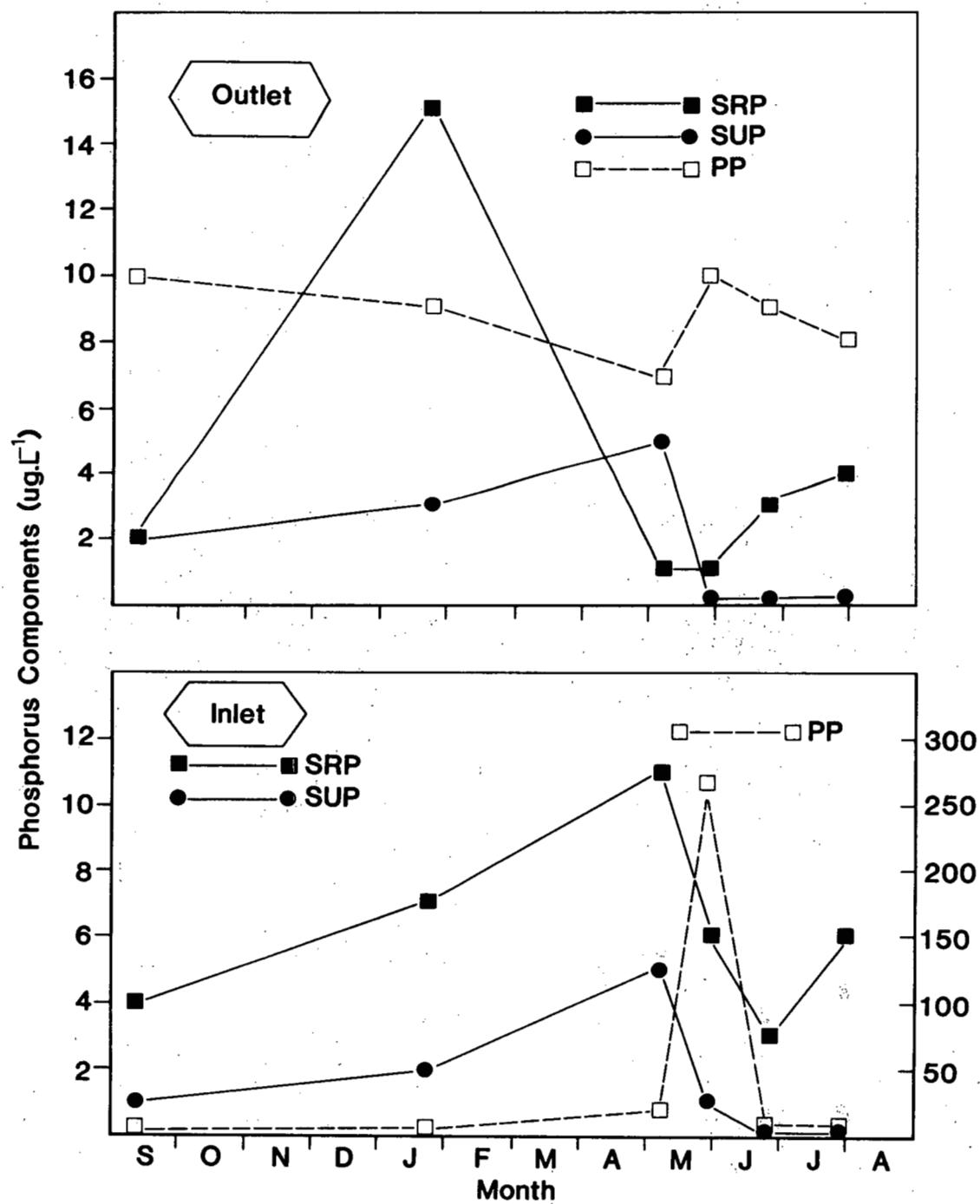


FIGURE 3: Skaha Lake outlet and inlet phosphorus concentration

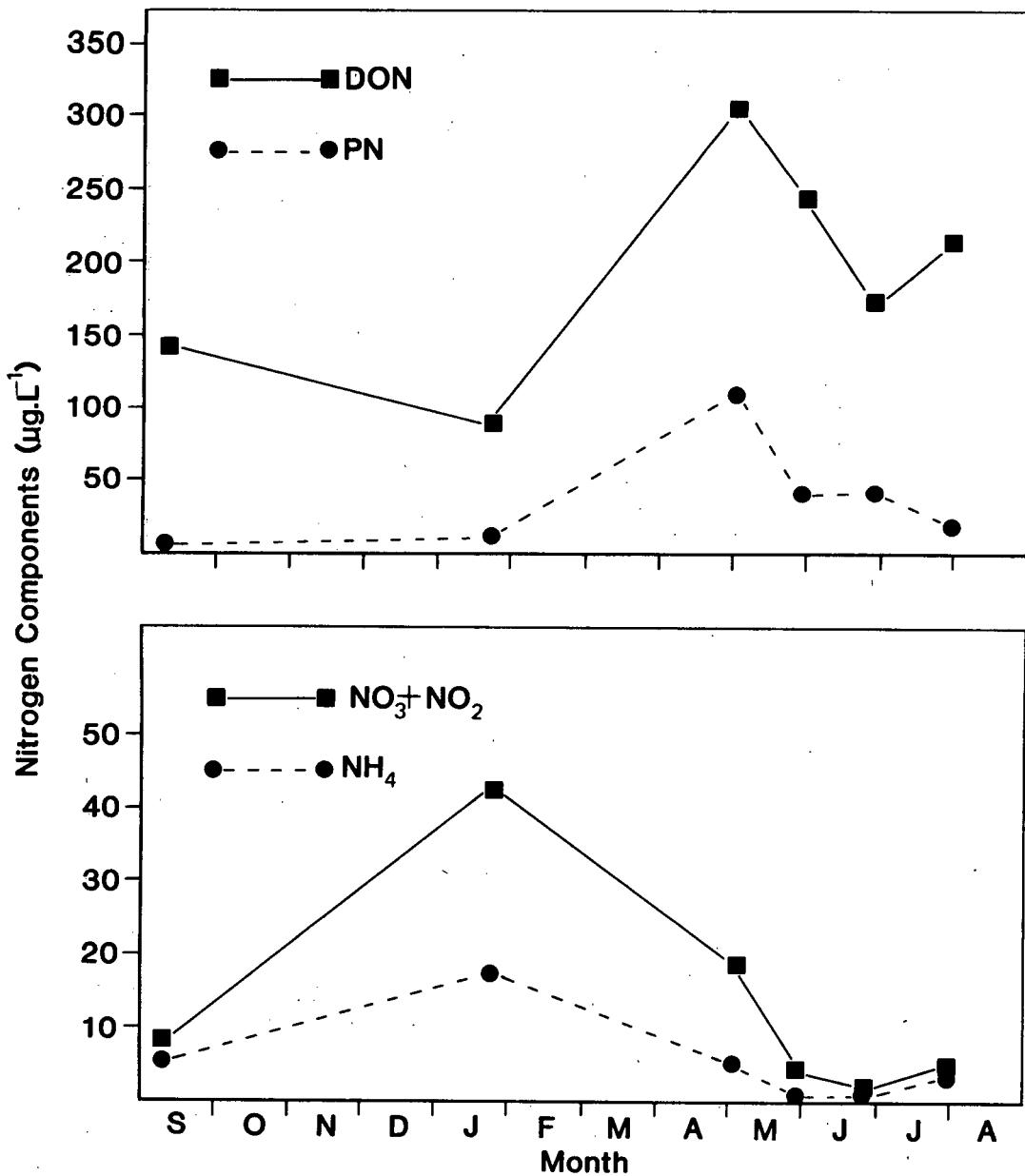


FIGURE 4: Lambly Creek nitrogen concentrations

Coldstream, Deep, Equesis, Trout, Mission). In these tributaries NN was usually the dominant N form and it was highest during autumn and winter (eg. Coldstream, Figure 5). Nitrite was also frequently observed in these polluted tributaries. PN was highest during spring runoff in all the mountain tributaries.

At the lake inlet stations, the basic compositional nature of the upstream lake outlet was modified by cultural and mountain tributary inputs. NN was usually noticeably elevated during low flow at stations where cultural inputs occurred. AN was the dominant DIN component in the Skaha Lake input. PN reached highest levels during spring freshet at those sites influenced by mountain tributaries.

In the lake outlets, DON was again the dominant form but it did not fluctuate appreciably like it did in the mountain tributaries (eg. Skaha Lk., Figure 6). NN was at its maximum during winter and often dropped below detection during summer. AN was generally low but occasionally increased up to $20\mu\text{g}\cdot\text{L}^{-1}$. PN was usually higher during the growing season but the difference between winter and summer was not great.

3.3.2. Relationships of PP and PN to turbidity.

When PP and PN were correlated with field-measured turbidity,

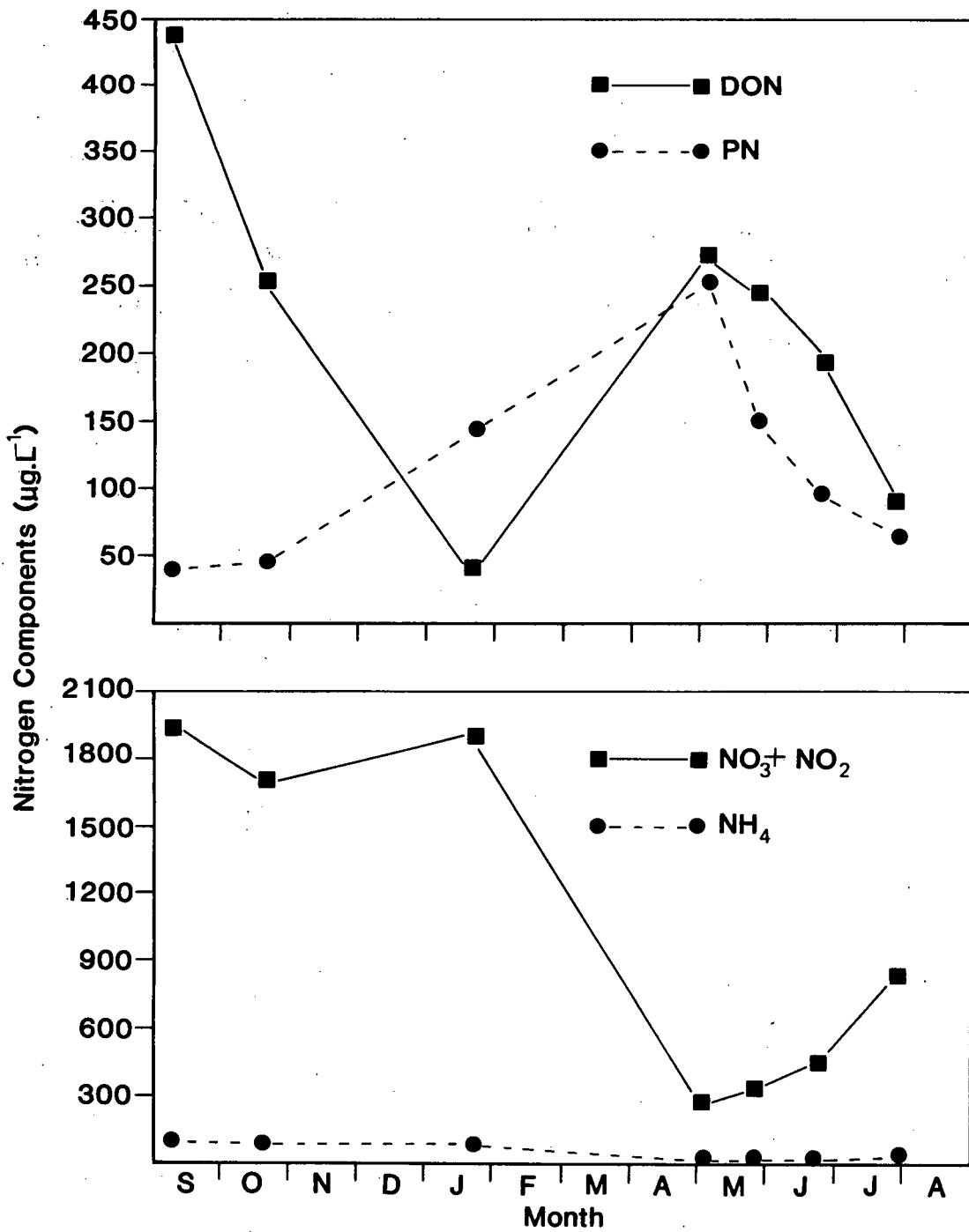


FIGURE 5: Coldstream Creek nitrogen concentrations

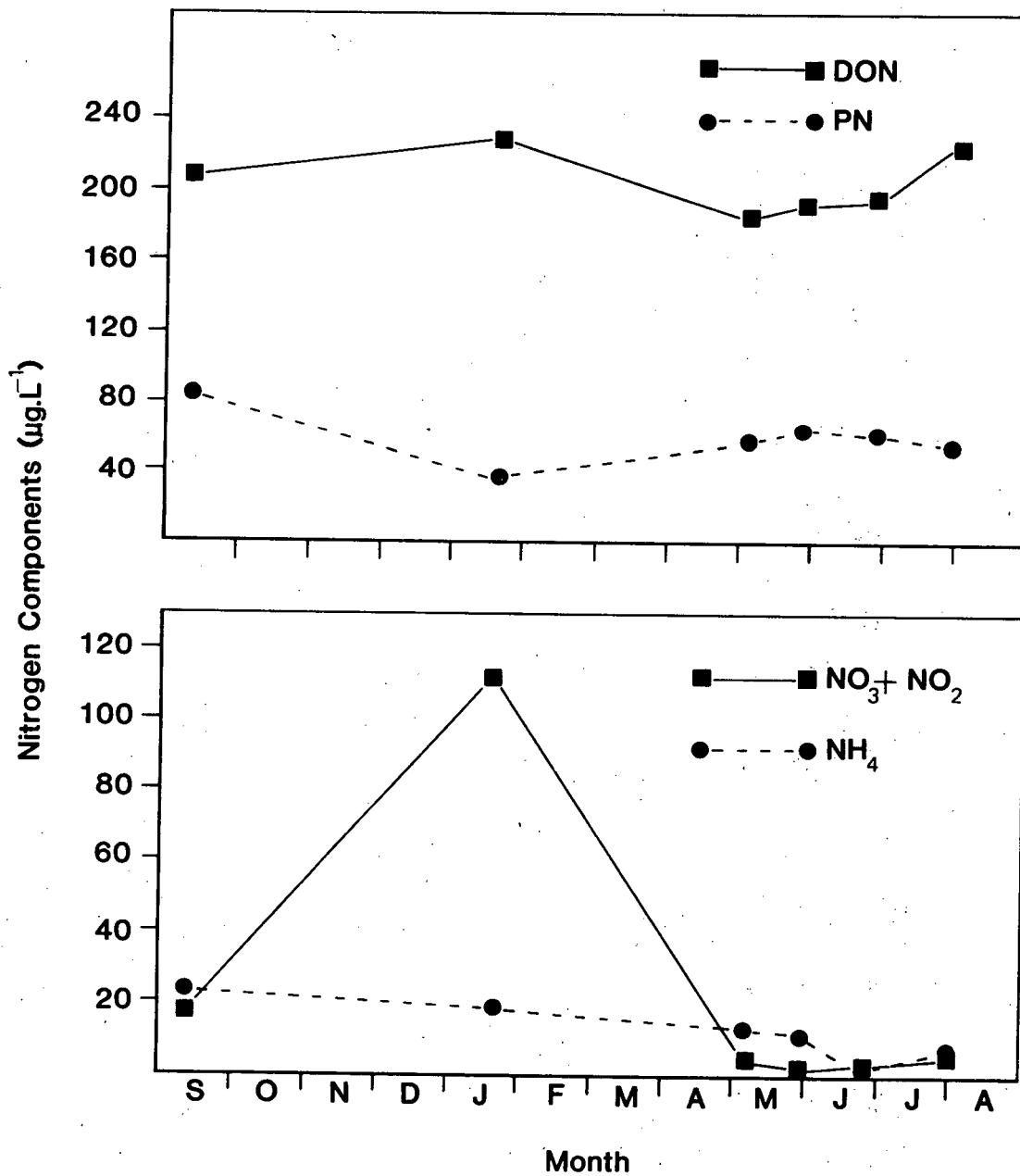


FIGURE 6: Skaha Lake outlet nitrogen concentrations

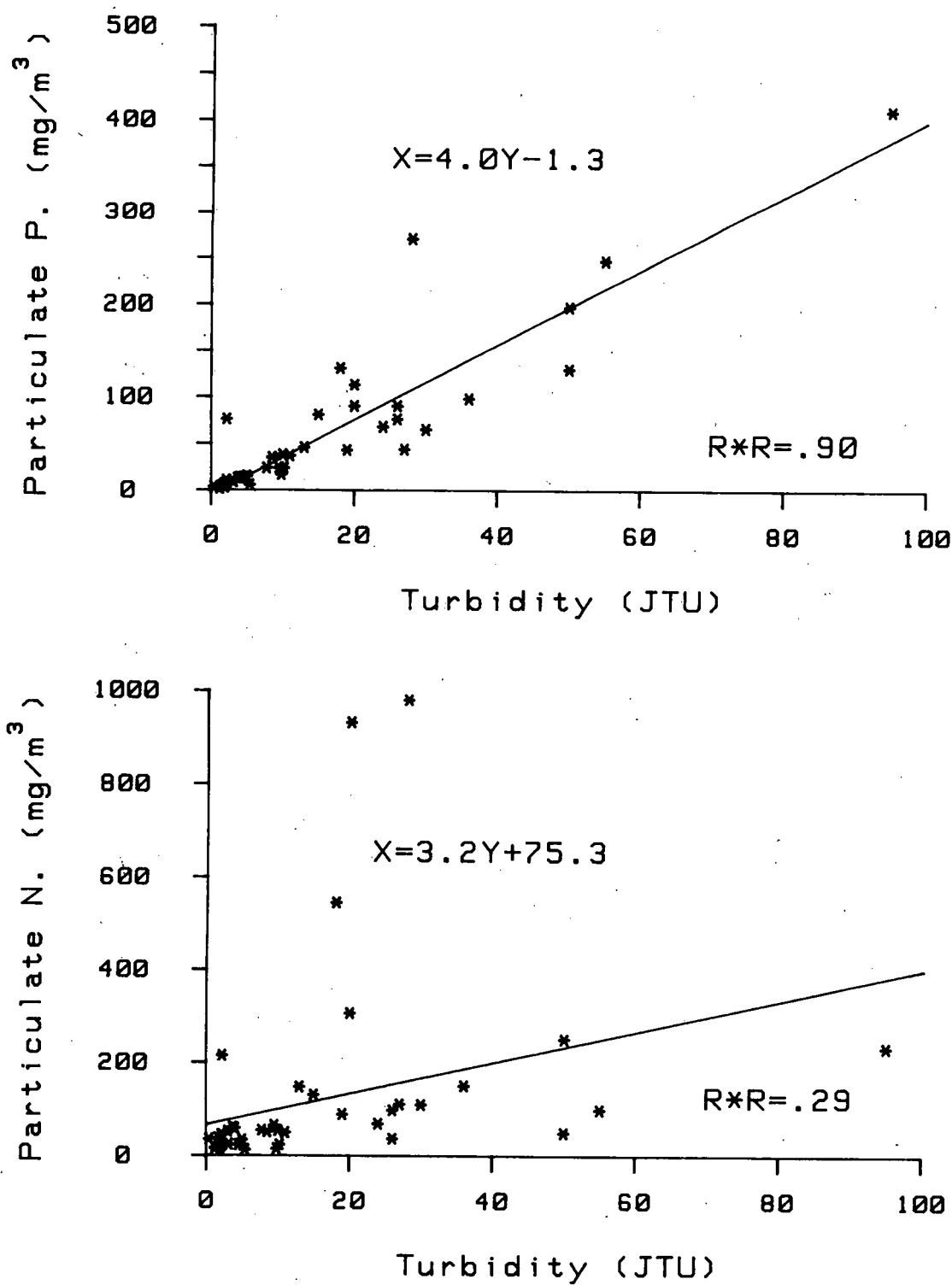


FIGURE 7: PP and PN versus turbidity in mountain tributaries

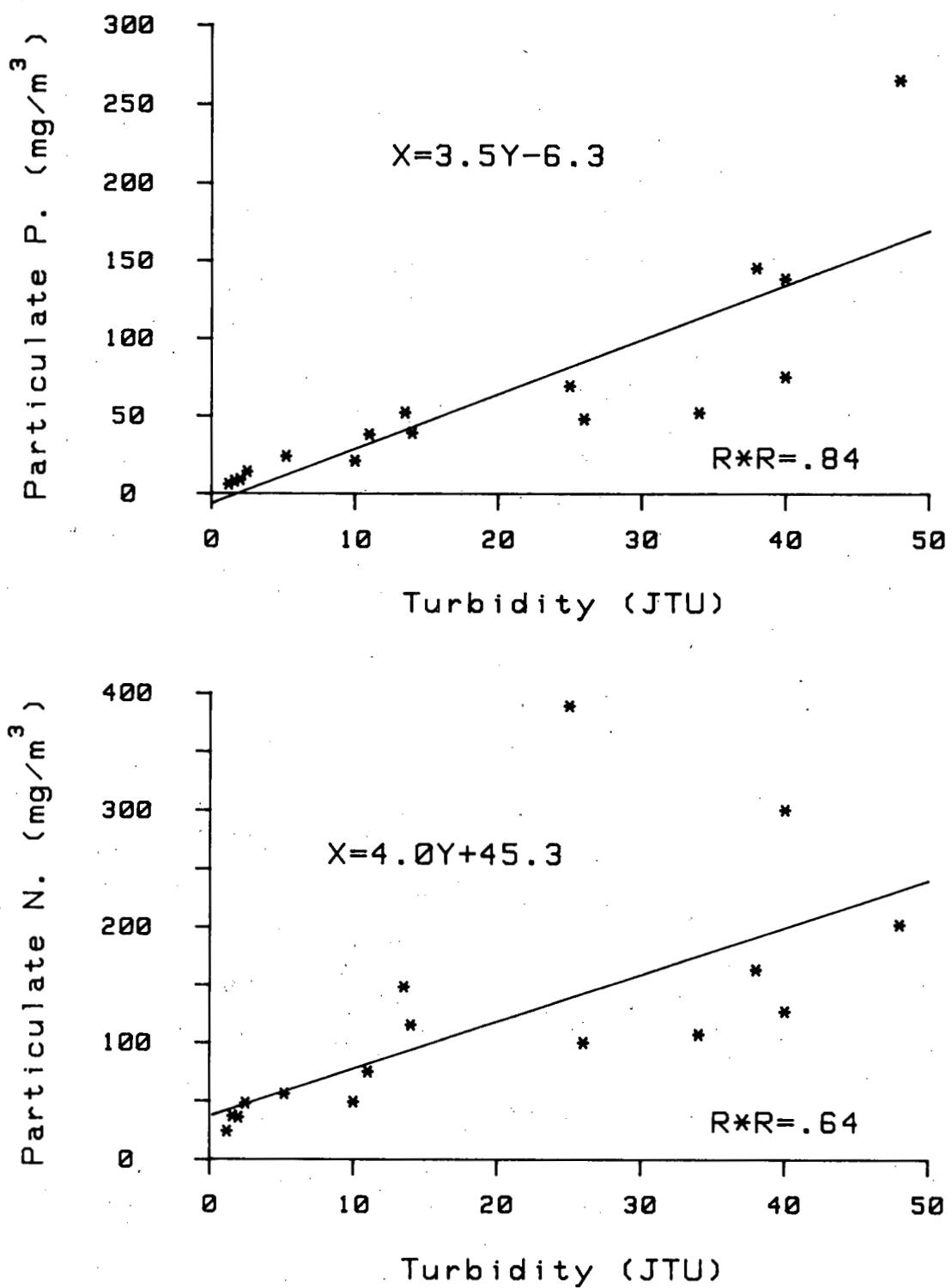


FIGURE 8: PP and PN versus turbidity in lake inlets

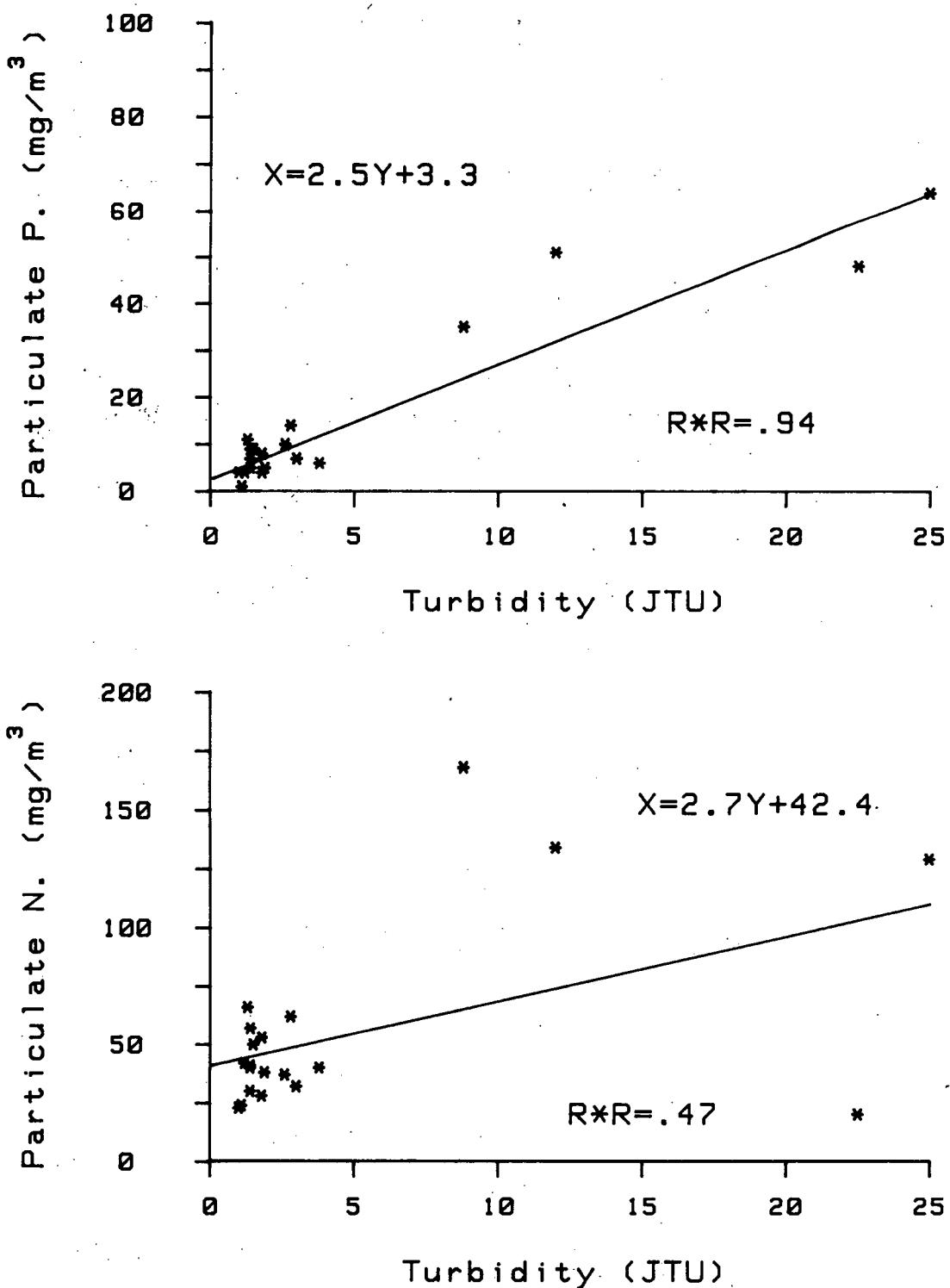


FIGURE 9: PP and PN versus turbidity in lake outlets

by linear regression, the correlations were good between PP and turbidity but not between PN and turbidity (Figures 7, 8 and 9). The slopes of the regression lines varied among the mountain tributaries, lake inlets and lake outlets. PP increased fastest with increasing turbidity in the mountain tributaries and slowest in lake outlets.

3.4. Suspended Sediment Sampling Results

The most common component of particulate phosphorus was apatite (AP), usually accounting for 40 to 80% of the total P (Table 6). The remaining P was made up almost equally of organic P (OP) and non-apatite inorganic P (NAIP).

Although the suspended sediments had as much as $3500 \mu\text{gP}\cdot\text{g}^{-1}$, the most frequent values occurred between 1000 and 1800 $\mu\text{gP}\cdot\text{g}^{-1}$. The most frequent concentration ranges for OP, NAIP and AP were 150-160, 100-400, and 800-1000 $\mu\text{gP}\cdot\text{g}^{-1}$, respectively (Figure 10).

There were several exceptions to the preceding generalizations. Deep Creek sediment had a very low amount of AP which only accounted for 7% of the TP while OP and NAIP were the highest measured together comprising more than 90% of the total. Samples from Underdown and Wabash Creeks also had low AP and high OP contents but NAIP was not greater than average. At the other extreme there was Trout Creek with the highest AP content which made up essentially

TABLE 6: Suspended Sediment Phosphorus Component Concentrations ($\mu\text{g}\cdot\text{g}^{-1}$)

STATION	TP	NAIP	OP	AP	AP % of TP
Equesis	1200	110	285	800	66
Deep	3470	1630	1570	270	7
Coldstream	1130	50	190	890	78
Vernon above Ellison	1400	275	470	660	47
Vernon above Wood Lake	1480	260	265	950	64
Vernon above Okanagan Lake	1055	255	240	560	53
Mission	1475	200	180	1020	69
Lambly	1250	195	265	790	63
Trout	1320	2	-25	1340	100
Shingle	1610	385	550	680	42
Shingle below Rogers Ranch ₁	1310	280	170	870	66
Shatford at bridge ₁	1785	360	490	930	52
Vaseux	1090	120	165	805	73
Vaseux at hydro-metric station ₂	1160	140	200	820	70
Underdown Creek ₂	1970	565	1180	225	11
Wabash Creek ₂	1695	315	1095	285	16
Upper Vaseux ₂	1120	140	430	550	49

1. Stations in the Shingle Creek drainage basin
 2. Stations in the Vaseux Creek drainage basin

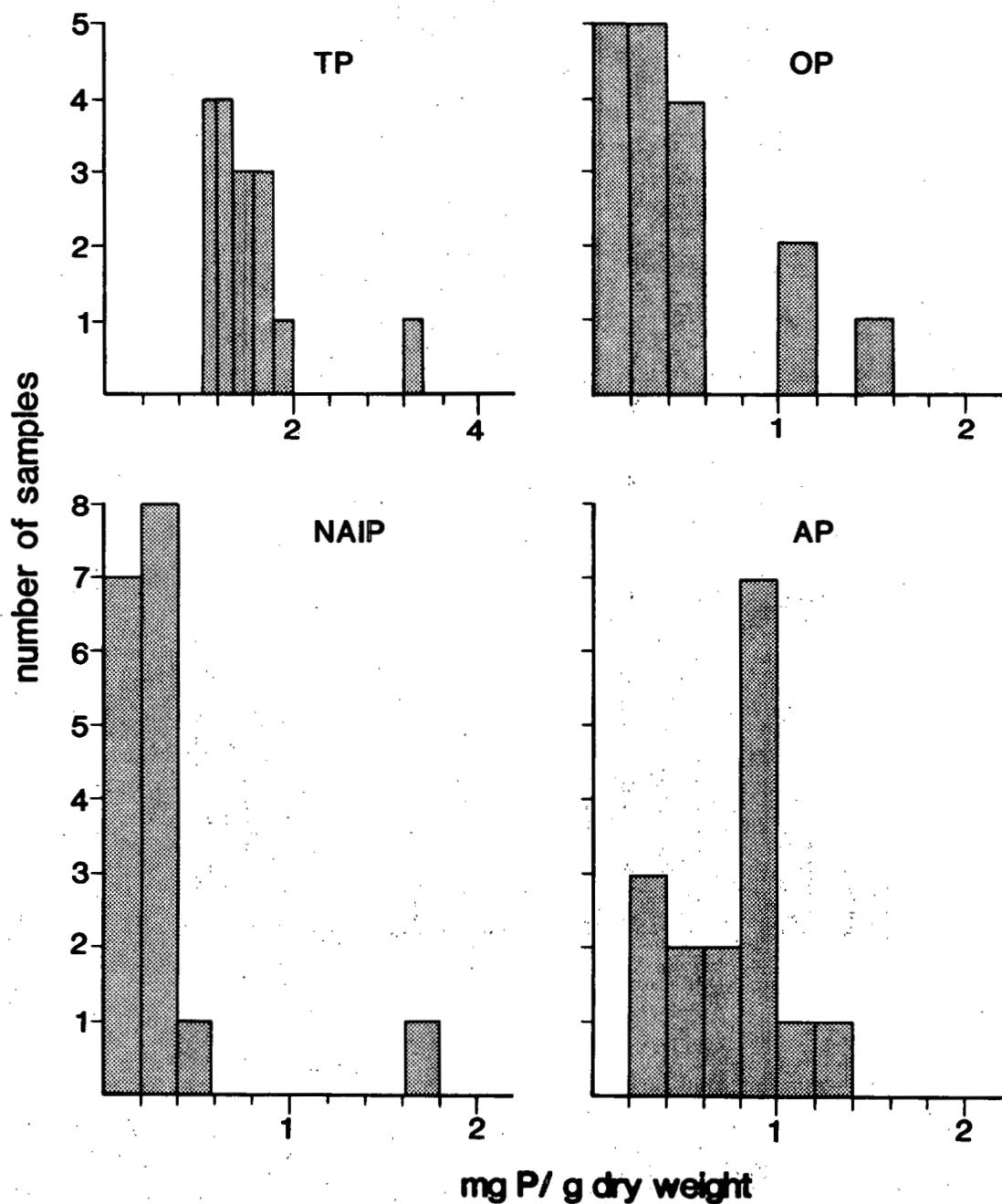


FIGURE 10: Frequency of TP, NAIP, OP and AP concentrations in 17 suspended sediment samples

100% of the TP at the time of sampling.

Concentrations of PP in the input and output streams of the centrifuge were measured to ascertain the recovery efficiency of the ENIVRODATA SediSamp System I. The average recovery was 87% and ranged between 79 and 95%, except for two small streams in the Vaseux Creek basin where recoveries of 43 and 100% were calculated. However, both locations had PP concentrations close to the detection limit, so the precision of these two estimates of recovery is probably poor.

On May 25, in the Shingle Creek basin, there was a heavy rainstorm which resulted in very high suspended sediment concentrations. Several water samples of this event were provided to us by the OBIB study team which was monitoring the stream. The suspended sediment in 1L of water was sufficient to harvest the required amount in the less than 64 micron size fraction for P analysis. These samples offered an opportunity to test the generalizations supported by our sampling which had occurred three weeks earlier.

The P composition of the suspended sediments sampled downstream of Rogers Ranch was almost identical (Table 7). Samples at Shatford Creek bridge and Shingle Creek mouth, however, showed considerable enrichment of AP in the rainstorm. Other stations at higher elevations in the drainage basin were sampled during the rainstorm and their analyses showed that AP increased over one third between

the Water Survey station and the bridge on Shatford Creek the major tributary of Shingle Creek.

TABLE 7: Comparison of P components in suspended sediments collected in Shingle Creek drainage basin on April 30 and May 25.

Station	Date	TP	NAIP	OP	AP	$\mu\text{g}\cdot\text{g}^{-1}$ (% of TP)
Shingle above Rogers Ranch	April 30	-----	No sample	-----	-----	-----
	May 25	1325	160	230	935	71
Shingle below Rogers Ranch	April 30	1310	280	170	870	66
	May 25	1380	240	240	900	65
Shatford at Apex Station	April 30	-----	No sample	-----	-----	-----
	May 25	1420	210	245	970	68
Shatford at Water Survey Station	April 30	-----	No sample	-----	-----	-----
	May 25	1465	290	275	905	62
Shatford at Bridge	April 30	1785	360	490	930	52
	May 25	1740	145	360	1240	71
Shingle Creek at Mouth	April 30	1610	385	550	680	42
	May 25	1530	275	225	1030	67

4. DISCUSSION

4.1. Definition and Computation of BAP and BAN

Since it is believed that phytoplankton produce the majority of the organic carbon in these lakes (Stockner and Northcote, 1974), the biological availability of N and P for phytoplankton was chosen as the criteria for defining BAP and BAN. Since most phytoplankton can only take up orthophosphate-P, nitrate-N, nitrite-N and ammonia-N directly, the availability of other dissolved and particulate forms of P and N depends on their rate of breakdown to these four components relative to their residence time in the water column. For example, apatite-P can be slowly dissolved in natural freshwater but the rate is so slow in relation to its sedimentation rate that it is essentially unavailable (Williams et al., 1980). In some cases the receiving environment can affect the definition of availability. For instance, adsorption of phosphate from lake water by suspended sediment input can sometimes remove available P from the water column (Green et al., 1978). Another example could arise, if the degradation of DON were slow relative to high flushing rates observed in some lakes (eg. Skaha and Osoyoos). Obviously these complications cannot be tackled in a preliminary investigation of this sort. The rates of release of the orthophosphate, nitrate, nitrite or ammonia from many specific particulate or dissolved compounds are not known. Also the ability to use experimentally measured release rates in the assessment of those rates in lakes is very poor at this time.

The simplest approach to the problem is to estimate the potential availability of the major components of P and N from data generated in this study and from literature estimates. These availability estimates can only be of the potential availability; estimations on actual availability in each receiving environment will not be attempted. The major components of BAP and BAN are as follows:

$$BAP = SRP + a(SUP) + b(PP)$$

$$BAN = DIN + c(DON) + d(PN)$$

where: a, b, c and d are availability coefficients

$$DIN = AN + NN$$

The choice of the availability coefficients in this study is based on data for coefficient b only, the others were based on some data and discussions in the literature, as detailed in the following discussion.

Soluble Reactive Phosphorus

This component is made up of orthophosphate and weakly associated phosphate in some high molecular weight colloids (Lean, 1973). While the orthophosphate is rapidly available, the latter may be only slowly available (Paerl and Downes, 1978). SRP was assumed to be completely available within the definitions of this study.

Soluble Unreactive Phosphorus

SUP is made up of identifiable organic compounds (eg. glycerophosphate, glucose-6-phosphate, DNA, adenylate phosphates, inositol phosphate, and phosphoproteins), unidentified phosphorus

compounds in humic and fulvic acids and phosphate in colloidal material which is not measured as SRP.

The degree of availability of each of the SUP components is varied. Initial research suggests that some of it is potentially available but that the proportion is variable (Peters, 1981). Francko and Heath (1979) found that much of the SUP in a eutrophic lake and a bog were converted to orthophosphate when alkaline phosphatase or low dose UV light was applied. Because of the ambiguities in the literature, it was decided to include all of this fraction in the potentially available category; in other words co-efficient a was arbitrarily set equal to one.

Particulate Phosphorus

Of the three components of PP, only Apatite (AP) is considered essentially unavailable (Williams et al., 1980). Various authors have found that fractions closely related to NAIP are available to bioassay organisms in short term incubations (Dorich et al., 1980, Verhoff and Heffner 1979, Williams et al., 1980; Depinto et al., 1981). On the otherhand, the availability of OP is not certain (Williams et al., 1980). Certainly the number of steps required to make this fraction available precludes rapid uptake by phytoplankton. Orthophosphate can be released from OP after hydrolysis by algal or bacterial phosphatases. These processes would occur to varying degrees depending on the receiving water environment. For instance, if a lake had extensive littoral zones

the likelihood of releasing phosphate from organic particles would be enhanced due to very active benthic fauna and bacterial populations. On the other hand if a lake had extensive pelagic zones and a rapid sedimentation rate in those zones then the extent of phosphate release before a particle was buried in the relatively inactive sediments would be low. In this treatment of availability, we have once again opted for "potential" availability as the criteria and would include OP in this category. Because of the foregoing arguments, coefficient b has been made proportional to the relative amount of NAIP and OP in the suspended sediment samples (Table 8). The coefficient was rounded off to the nearest tenth to reflect the frequency of sampling.

Dissolved Inorganic Nitrogen

Ammonium is usually most rapidly taken up by photoplankton, followed by nitrite and nitrate (Murphy, 1980). Since there is essentially complete specificity in the analyses of these components, the problems that arise in differentiating orthophosphate from other SRP components do not arise in evaluating the availability of DIN.

Dissolved Organic Nitrogen

Dissolved organic nitrogen consists of identifiable organic compounds (eg. amino acids, proteins, DNA, amino sugars, urea) and unidentifiable nitrogen-containing organic compounds in humic and fulvic acids. Urea is available to phytoplankton although at a slower rate than ammonium (McCarthy, 1972). Very little information

TABLE 8: Particulate P Bioavailability Coefficient

Sampled	
Tributary	Coefficient
Deep	0.9
Vernon above Ellison, Wood and Okanagan Lakes	0.5
Shingle	
Lambly	
Equesis	0.4
Vaseux	0.3
Mission	
Coldstream	0.2
Trout	0.1

is available on the availability of the other DON components. Cowen et al. (1978) presented data for organic nitrogen (particulate and dissolved) in tributaries of Lake Ontario. They found between 30 and 60% of the total organic N was available.

An estimate of availability of DON in the Okanagan basin was obtained by comparing suitably averaged input concentrations to the mid-winter outflow concentrations of Wood, Kalamalka and Okanagan lakes. The suitably averaged input concentration was obtained by multiplying the volume-weighted mean of the input by an evaporation correction. The result would be the concentration in the lake if DON was a conservative component like chloride. Outflow concentrations in winter were used to reflect lake concentrations in general. This comparison showed that DON in the lake decreased 42 to 64% relative to input concentrations (Table 9). The equating of this percentage decrease to the bioavailability of the DON must be considered very preliminary and a gross estimate. For instance, it assumes that all the DON, produced by phytoplankton in the lake, is degraded before mid-winter.

Taking both Lake Ontario and Okanagan Basin evidence into consideration, coefficient c was arbitrarily set equal to 0.5.

Particulate Nitrogen

Particulate nitrogen is mostly organic although some could be ammonium associated with clays. Since our PN analysis method

TABLE 9: Comparison of inflow and outlet concentrations of
DON ($\mu\text{g}\cdot\text{L}^{-1}$)

Lake	Volume Weighted Inflow Concentration a	Volume Evaporation correction b	Corrected Inflow Concentration c	Winter Outlet Concentration d	%DON $\frac{c-d}{c} \times 100\%$
<u>Wood Lake</u>					
Vernon	334	1.55	517	298	42
<u>Kalamalka Lake</u>					
Coldstream,					
Wood Lake					
outlet	275	1.57	431	156	64
<u>Okanagan Lake</u>					
Equestis					
Deep					
Vernon	250	1.34	335	134	60
Mission					
Lamby					
Trout					
Sewage Effluent*					

*Randtke and McCarty (1977)

involves combustion in a CHN analyzer which would not quantitatively recover the clay associated ammonium, the PN values were assumed to be entirely organic. The type of organic particles was not investigated directly by microscopy. General indications of the composition could be deduced from the PC/PN ratio. This ratio usually ranged between 10 and 20 and was indicative of a mixture of fresh organic matter, soil, and forest litter. There have not been specific studies of the availability of nitrogen from these particles. Cowen et al. (1978) estimated that half of the total organic nitrogen (dissolved and particulate) was available in tributaries of Lake Ontario; the relative contribution of the dissolved and particulate nitrogen to the bio-availability was not investigated. The decision to assign availability to the PN fraction was somewhat arbitrary in light of no specific data. We chose to assign a coefficient of 1.0 as the upper limit of the potential availability.

4.2. Relative BAP and BAN Loadings

The relative amounts of BAP and BAN in total loadings were estimated by a discharge weighting technique which multiplied average concentrations in low and high flow periods by 10 year average discharge in each period. The average concentrations in each period were obtained after BAP and BAN were calculated using the previously discussed formulae. The coefficients of the formulae were assumed to be the same for both high and low flow. More complicated and potentially better discharge weighting techniques

(Dolan et. al., 1981) could not be attempted with the limited frequency of the data.

The assignment of high and low flow periods was arbitrary but it usually involved calculating the average amount of discharge for the May and June period. The assignment of a specific sampling date to the high or flow period depended on the actual flow for 1980-1981. This results in some samples occurring in May which were low flow and some in July which were high flow. These samples were averaged with the data from the appropriate flow regime. At several stations there was no recent discharge data (eg. Vernon above Hiram Walker, and at outlet of Ellison Lk, Shingle at the mouth, Deep at the mouth, Lambly at the mouth) and the older data may not have been of 10 years duration.

The flow periods used for calculation of BAP and BAN contents in lake outlets were winter and growing season, to reflect the fact that dissolved nutrient concentrations are highest during winter and almost undetectable in some cases during summer. Since suspended sediments were not collected in the outlets, it was necessary to guess the BAP content of the PP. It was assumed to be 90% based on the general observation that the majority of the PP would be organic detritus produced within the lake.

BAP content ranged from 16 to 98% of TP loadings whereas BAN content ranged from 58 to 98% of TN (Table 10). The very large range

in BAP contents reflects the effects of highly variable contributions of apatite in the particulate matter as well as the highly variable yield of particulate matter from each tributary. The much smaller range of BAN content demonstrates the consistently high proportion of DON in the loading from different drainage basins.

Table 10: 10 year discharge-averaged BAP and BAN loadings as a percent of TP and TN loadings

Tributary	% BAP*	% BAN*
1. Mountain Tributaries		
Deep	96	76
Equesis	57	76
Coldstream	44	90
Vernon above Hiram-Walker	77	59
Vernon below Hiram-Walker	73	58
Winfield	98	98
Mission	41	72
Lambsly	65	62
Trout	16	69
Shingle	55	7
Vaseux	48	59
2. Valley Tributaries		
a) Lake inlets		
Vernon at Wood	60	82
Vernon at Okanagan	74	80
Okanagan at Skaha	44	75
Okanagan at Osoyoos	57	70
b) Lake outlets		
Ellison	92	76
Woods	98	63
Kalamalka	94	62
Okanagan	87	62
Skaha	94	66

* Detailed calculations are available in Appendix II.

5. CONCLUSIONS

SRP was the most common constituent of the TP components except during the high discharge periods when PP became the dominant form. SUP rarely became more important than SRP and only during early freshet.

DON was the dominant form of N in most tributaries and was at its highest concentration during early freshet. On the other hand, NN and AN were at their lowest concentrations during freshet and summer. In tributaries influenced by cultural inputs, NN was usually the most common component, although AN was the dominant DIN component in the Okanagan River above Skaha Lake.

PP was highly correlated with turbidity whereas PN was not. This close correspondence between PP and turbidity could allow continuous monitoring data of turbidity to be transformed into continuous PP data. Since the variability of DP concentrations is liable to be much less than that of PP, better TP loading estimates could be obtained if automatic water samplers and turbidity sensors can be combined with continuous measurement of discharge.

The suspended sediment was relatively rich in P compared to suspended sediment from the Great Lakes Basin where extensive studies have been carried out (Logan et al., 1979). The relative proportions of AP/NAIP/OP, however, showed that the Okanagan sediments were higher in AP only. This reflects the source of most of the PP in the tributaries. In

the mountain tributaries, the erosional components were mainly from cut banks which are made up of glacial deposits and are rich in AP. In Deep Creek, on the other hand, surface runoff from agricultural land provides most of the sediments and they are rich in NAIP and OP, much like the sediments of the Great Lakes Basin.

The seasonal variation in the composition of PP was not investigated in this study. Although the majority of the loading of PP occurs in spring when we sampled the suspended sediments, the effect of compositional changes during low discharge periods could be large enough to negate some of the conclusions advanced here. It is likely that suspended sediments from low discharge periods will be characterized by higher NAIP and OP contents as well as a higher overall TP content (Ongley et. al., 1981).

The impact of higher bioavailability during periods of low PP loading remains to be evaluated.

The potential biological availability of the nutrient inputs to the Okanagan Valley lakes varies considerably; especially for phosphorus. The relative annual BAP loadings ranged between 16 and 98% of the TP loadings. The relative annual BAN loadings ranged between 58 and 98% of the TN loadings. The stations with high relative percentages for BAN were usually those strongly influenced by cultural activities in the drainage basin (eg. Coldstream, Deep, Winfield, Vernon above Wood and Okanagan). However, the stations with high relative percentages of BAP were not uniformly those influenced strongly by cultural influences. In fact the station with the third highest BAP percentage (77%) was Vernon

above Hiram Walker which has very little cultural input. Lambly also had a higher BAP content than most at 65%. In contrast Coldstream's TP input was only 44% available even though it is heavily influenced by cultural inputs. Knowledge of BAP content also changed the importance of TP loading from Trout Creek which is a major contributor of TP to the basin (Tech. Suppl. IV, 1974). In fact the BAP loading for Trout Creek was less than that of Shingle Creek which is an average contributor of TP.

The potential biological availability of the nutrient exports from the lakes was consistently high for phosphorus and low for nitrogen. BAP content averaged 93% whereas the BAN content averaged 63% except for Ellison which was 76%. Since lake outlet chemistry reflects the compositional characteristics of the surface layers of the lake, it is not surprising that the BAN content was low because the available components were utilized by the phytoplankton throughout the growing season. The high BAP content, however, is somewhat baffling. Because of the definition used here and the assumption that 90% of the PP was available it could not be otherwise. In reality, the availability of the SUP content in lake surface waters must be lower than the 100% assumed in this investigation.

While selection of availability coefficients, was partly arbitrary, it should be emphasized that the biological availability estimates derived from them were liable to be maximum estimates. The rate at which these potentially available fractions are actually utilized remains a subject for further study. In systems with short water residence-times (eg.

Skaha and Osoyoos Lakes), the actual BAP and BAN utilized is probably much lower than the potential. Conversely, in Okanagan Lake, the long residence time should lead to greater utilization.

The BAP and BAN loading information provided by this report should affect some water quality management strategies in the basin for several reasons. First, the utility of TP loading estimates for deciding where control measures are required is very poor in this basin because in many instances the potential BAP loadings are less than 50% of TP loadings. Fortunately the utility of TN loading estimates is greater but depends on the effective availability of DON as opposed to the 50% potential availability assumed here. Many of the N inputs from tributaries draining undeveloped areas are rich in DON so that if effective availabilities of DON are lower than 50% the overall availability would be reduced to a greater extent than would be the case in tributaries with high concentrations of nitrate or ammonium.

Second, the present management strategy of limiting suspended sediment inputs, as a way of reducing P loading, must be selective in its application because the effectiveness of this policy depends on the BAP content of the suspended sediments. For example, controlling suspended sediments in Trout Creek (0% BAP content) would be unsuccessful in controlling eutrophication compared to erosion control in the Deep Creek drainage basin (90% BAP content).

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APPENDIX I

Water Sample

Chemical Analysis Data

DATE/TIME	DEEP CRK (58° 20' 58" N 119° 17' 50" W)	GENERAL PHYS./CHEM				
	Temp C	C25	Turb. MWRI	Turb. WOB	SiO2	C1
800908.0920	13.0	691.0	.98	.98	28.5	5.5
801019.1020	12.0	688.0	3.00	27.0	4.4	
810120.0930	4.0	702.0	2.20	.66	30.5	5.4
810503.1020	11.9	614.0	28.00	20.00	5.5	9.5
810526.0935	15.5	494.0	20.00	7.00	16.6	5.9
810623.1135	16.1	455.0	18.00		15.2	5.2
810727.1340	23.0	570.0	20.00		21.6	4.8

DATE/TIME	DEEP	CRK	(50 20'58" N 119 17'50" W)	PHOSPHORUS			PP	PP/TF
				TP	DP	SRP/TP		
	390	368		338				
	386	370		351				
	387	362		363				
800908, 0920	388	367	.95	351	.90	.96	.21	.05
	360	345		336				
	360	340		349				
	360	345		342				
801019, 1020	360	343	.95	342	.95	1.00	.17	.05
	470	390		346				
	470	390		362				
	450	380		362				
810120, 0930	463	387	.83	357	.77	.92	.77	.17
	490	84		60				
	285	84		62				
	290	83		61				
810503, 1020	355	84	.24	61	.17	.73	.271	.76
	245	139		109				
	220	140		105				
	225	140		108				
810526, 0935	230	140	.61	107	.47	.77	.90	.39
	280	143		133				
	290	157		137				
	280	157		137				
810623, 1135	283	152	.54	136	.48	.89	131	.46
	365	250		218				
	365	250		226				
	365	255		223				
810727, 1340	365	252	.69	222	.61	.88	113	.31

DATE/TIME	DEEP CRK (59 26'58"N 119 17'50"W)	NITROGEN						PC	
		TN	TDN	CRK	NH3	NO2	N+N	NH4	DIN
	1800	77	181	22	203	72	275	1525	.710
	3200		186	17	203	93	296	2904	
	1000		188	20	200	79	279	721	
	2000	77	182	20	202	81	283	1717	.710
	765	67	206	24	238	89	319	446	.546
	780	71	207	23	238	86	316	464	.576
	785	74	206	24	238	85	315	470	.583
800908.0920	2077	77	206	24	239	87	317	460	.568
	1100	203	241	9	250	700	950	150	1.880
	1150	218	240	10	250	730	980	170	1.750
	1200	224	240	10	250	710	960	240	1.960
	1150	215	240	10	250	713	963	187	1.863
	685	1010	2	2	4	27	31	654	6.501
	715	949	4	4	8	30	38	677	5.962
	695		4	3	7	27	34	661	
810120.0930	1365	698	980	3	6	28	34	664	6.232
	690	328	43	6	49	87	136	554	3.410
	720	283	41	9	50	62	112	608	2.960
	695		39	9	48	82	130	565	
810526.0935	1007	702	306	41	49	77	126	576	3.185
	545	545	8	1	9	1	10	535	3.960
	545		11	4	15	8	16	529	
	545	545	6	2	11	5	15	530	3.960
810623.1135	1090	545							
	882	909	126	39	165	48	205	677	4.605
	788	955	125	39	164	28	184	604	4.650
	990		113	35	148	75	223	767	
810727.1340	1819	887	932	121	38	159	45	204	683

DATE/TIME	EGEESIS CRK (50 17/18°N 119 24'38"E)	GENERAL PHYS/CHEM				
	Temp C	C25	Turb HWT	Turb WOB	SiO2	C1
800526.1200	369.0		1.20	24.1	24.0	24.2
				24.1	24.0	24.1
800908.1000	9.0	436.0	34	23.0	1.1	
				22.5	9	
810120.0904	3.5	443.0	.38	.15		
810503.0845	4.1	83.3	15.00	15.00	14.6	9
810526.0905	6.9	170.0	26.00	7.60	24.0	6
810623.1005	8.9	209.0	3.00		24.7	6
810727.1315	14.5	318.0	4.00		23.8	9

DATE/TIME	EQUESIS	CRK	17°18'N 119°38'W)			PHOSPHORUS			PP	PP/TP
			TP	DP	DP/TP	SRP	SRP/TP	SRP/DP		
800526.1200	29	28		24						
	28	24		24						
	29	24		24						
800908.1000	29	25	.88	24		.84		.95	3	.12
	29	24		24						
	26	24		29						
810120.0904	27	23		28						
	27	23		21						
	27	23		21						
810503.0845	27	23	.85	21		.79		.93	4	.15
	94	16		25						
	105	18		25						
810526.0905	94	16		25						
	98	17	.17	25						
	103	27		26						
810623.1005	105	26		20						
	106	27		21						
	98	27		21						
810727.1315	103	27		21						
	35	23		30						
	34	22		28						
	34	23		27						
	34	23		28						
	34	23		28						
	43	29		29						
	43	30		29						
	42	29		27						
	43	29	.69	27		.68		.99	13	.31

DATE/TIME	CRK C50	17/18/N	119	24/38/W	NITROGEN RATIOS
	TDN/TN	PN/TN	NN/TN	DIN/TN	AN/DIN DIN/DN DON/TN DON/DN PC/PN
800526.1200	.96	.04		.49	.51
	.93	.07		.47	.53
	.99	.01		.47	.53
	.95	.05		.47	.53
	.94	.06		.78	.22
	.94	.06		.76	.24
	.95	.05		.75	.25
	.96	.06	.73	.77	.23
800908.1000	.96	.04		.22	.15
	.97	.03		.87	.13
	.99	.01		.63	.17
	.99	.01		.67	.13
	.98	.02	.79	.66	.13
810120.0904	.91	.09		.21	.14
	.92	.08		.19	.14
	.93	.07		.18	.82
	.93	.07	.14	.26	.88
810503.0845	.69	.31		.79	.14
	.82	.18		.28	.72
	.96	.04		.26	.74
810526.0905	.74	.26	.91	.27	.17
	.99	.01		.55	.65
	.94	.06		.44	.56
	.95	.05		.45	.55
	.96	.04	.34	.41	.59
810623.1005	.83	.17		.43	.57
	.99	.01		.56	.58
	.99	.01	.40	.46	.47
810727.1315	.88	.12	.99	.01	.16

DATE/TIME	Temp C	C25	Turb MWT	Turb WGT	GENERAL PHYS/CHEM	C1
					17.4	
					17.3	
					17.5	
800527.0000	456.0		18.00		17.4	
800908.1520	13.0	636.0		.79	20.5	7.0
801019.1300	8.0	559.0		.69	20.5	6.9
810120.1033	4.0	660.0		1.10	20.2	7.6
810503.1355	6.0	222.0	50.00	30.00	15.8	1.9
810526.1100	9.4	279.0	36.00	12.00	16.2	2.0
810623.1550	11.5	307.0	19.00		17.2	2.0
810728.1130	14.0	416.0	9.50		18.4	3.1

DATE/TIME	COLDSTREAM CRK (50° 13' 28" N 119° 15' 38" W)				NITROGEN				PC
	TN	TDW	PH	NOS	NO2	N+H	NH4	DIN	
800527.0000	1350	1090	10	1100	15	1115	235		
	1500	991	9	1000	22	1022	478		
	1300	1090	10	1100	18	1118	182		
	1383	1057	10	1067	18	1085	298		
	2550	36	1926	4	1930	74	2004	546	.489
	2400		1946	4	1950	68	2038	362	
	2450		1935	5	1940	92	2032	418	
	2467	36	1936	4	1940	85	2025	442	.489
	2100	50	1685	5	1680	61	1741		.557
	1900	38	1675	5	1680	68	1758	342	.609
	2000	44	1678	5	1683	64	1743	157	.482
801019.1300	2044	2000		1906	14	1920	59	1979	71
	2050	163		1906	14	1920	65	1985	15
	2000	165	1906	14	1920	63	1983	17	3.226
	2000	103	1907	13	1920	62	1982	34	.549
810120.1633	2160	2017	144	1906	14	1920			
	535.	248		255	5	260	1	261	274
	555.	254		275	5	280	1	281	274
	539			255	5	260	1	261	269
810503.1355	791	540	251	262	5	267	1	268	272
	585	141		335	5	340	6	346	239
	560	158	313	7	320	2	322	238	2.836
	585			315	5	320	2	322	263
810526.1100	726	577	150	321	6	327	3	330	247
	638	85	447	3	450	1	451	187	1.260
	687	93	447	3	450	9	459	228	1.446
	633		448	2	450	5	455	178	
810623.1550	742	653	89	447	3	450	5	455	198
	930	64		870	5	875	42	917	13
	950	65		796	4	800	34	834	116
	950			771	4	775	48	815	135
810728.1130	1006	943	65	812	4	817	39	855	88

COLDSTREAM CRK 050 13'28" N 119°15'38"E NITROGEN RATIOS						
DATE/TIME	TDN/TH	PN/TH	NN/DIN	AN/DIN	DIN/TH	DN/TH DON/TH PC/TH
800527.0000	.99	.91	.83	.83	.17	
	.98	.92	.68	.68	.32	
	.98	.92	.86	.86	.14	
	.98	.92	.78	.78	.22	
	.96	.94	.79	.79	.21	14
	.96	.94	.85	.85	.15	
	.95	.95	.83	.83	.17	
	.96	.94	.82	.82	.18	14
800908.1520	.99	.91	.96	.94	.16	
	.96	.94	.84	.84	.16	12
	.96	.94	.92	.92	.08	13
	.96	.94	.85	.87	.12	13
	.96	.94	.82	.82	.13	
	.96	.94	.83	.84	.16	
	.96	.94	.99	.99	.01	20
	.96	.94	.99	.99	.01	
801019.1300	.98	.92	.97	.97	.03	17
	.97	.93	.99	.99	.01	
	.97	.93	.99	.99	.01	
	.97	.93	.98	.98	.02	21
	.97	.93	.98	.98	.02	
810120.1033	.93	.67	1.00	0.99	.51	15
	1.00	0.99	1.00	0.99	.49	
	1.00	0.99	1.00	0.99	.49	
	1.00	0.99	1.00	0.99	.51	
	1.00	0.99	1.00	0.99	.50	15
810503.1355	.68	.32	1.00	0.99	.34	
	1.00	0.99	1.00	0.99	.34	
	1.00	0.99	1.00	0.99	.34	
	1.00	0.99	1.00	0.99	.34	
810526.1100	.79	.21	.98	.92	.41	17
	.99	.91	.99	.91	.43	18
	.99	.91	.99	.91	.45	
	.99	.91	.99	.91	.43	18
	.99	.91	.99	.91	.43	
810623.1550	.88	.12	1.00	0.99	.71	15
	.98	.92	1.00	0.99	.67	
	.99	.91	1.00	0.99	.72	
	.99	.91	1.00	0.99	.70	
	.99	.91	1.00	0.99	.70	
	.96	.94	1.00	0.99	.68	
	.95	.95	1.00	0.99	.66	
	.95	.95	1.00	0.99	.66	
	.95	.95	1.00	0.99	.61	
810728.1130	.94	.06	.95	.95	.91	14
	.96	.95	.95	.95	.91	
	.95	.95	.95	.95	.91	
	.95	.95	.95	.95	.91	

DATE/TIME	Temp C	C25	Turb NBR1	Turb NBR2	GENERAL PHYS/CHEM
800528.0000	115.0		2.50	19.7	19.7
800909.1250	12.0		97.7	55	9.3
801019.1500	8.0		241.0	64	11.2
810121.1600	2.6		82.0	35	9.4
810504.1645	3.15		86.2	7.75	4.30
810527.1610	9.8		61.6	11.00	3.00
810624.0940	10.0		70.0	2.30	12.8
810728.0900	16.2		83.0	2.00	12.6

DATE/TIME	VERNON CRK above H.W. 050			00'50''N 111°23'W)			NITROGEN			PC
	TH	TDN	PN	N03	N02	N+N	NH4	DIN	DON	
8006528.0000	436	4	4	6	12	18	418			
	405	3	3	5	10	15	391			
	401	2	2	4	10	14	387			
	414	3	2	5	11	16	399			
	600	56	47	1	48	41	89	511	.734	
	580	59	1	68	47	107	473			
	550	54	1	55	54	109	441			
	56	53	1	54	47	102	475	.734		
8009009.1250	633	577	268	27	11	14	1	15	245	.308
	265	26	10	4	14	1	15	250	.325	
	265	27	11	2	13	1	14	251	.312	
	263	27	11	0	14	1	15	249	.315	
8010119.1500	291	300	25	79	1	89	0	89	212	.508
	290	25	78	1	79	5	84	206	.569	
	340	25	66	1	81	9	90	250	.608	
	310	25	79	1	80	7	67	223	.562	
810121.1000	335	360	56	8	16	0	19	341	.822	
	365	53	7	6	13	4	17	348	.844	
	360	55	6	6	14	6	20	346		
	362	55	6	6	14	4	19	343	.833	
8105004.1045	416	330	46	8	0	11	1	12	318	.741
	350	53	13	2	15	6	21	329	.740	
	340	50	11	2	13	0	16	324		
	340	50	11	2	13	3	16	324	.741	
810527.1010	390	290	23	3	6	1	7	283	.259	
	364	25	13	0	15	11	26	338	.256	
	332	24	10	9	13	14	27	305		
	329	24	9	3	11	9	20	309	.258	
810624.0940	353	425	26	33	2	35	0	38	.387	.372
	352	30	50	1	51	5	56	296	.345	
	326	30	1	31	1	32	294			
	368	28	38	1	39	0	42	.326	.359	

VERNON CRK below H.W. (50 00' 13" N 119 23' 16" W) GENERAL PHYS/CHEM
DATE/TIME C25 Temp C NMR Turb WOB SiO₂ C1

800909.1325	16.0	146.0	.56	7.8	.79
810121.1050	5.9	108.0	.38	8.8	.9
810527.1110	10.6	68.1	10.00	3.00	12.5
810624.1025	12.0	87.0	1.90	11.9	.8
810728.0935	17.0	93.0	1.90	12.3	.7

DATE/TIME	VERNON CRK above H.W. 050 00' 50" N 119 23' 00" W	NITROGEN RATIOS								
		TDN/TN	PN/TN	PH/TN	NH4/TN	AN/DIN	DIN/TN	DIN/DN	DON/TN	DON/DN
800528.0000		.33	.67			.04			.96	
		.33	.67			.04			.96	
		.29	.71			.03			.97	
		.32	.68			.04			.96	
		.54	.46			.15			.65	
		.56	.44			.18			.82	
		.59	.50			.20			.88	
	800909.1250	.91	.69	.53	.47	.16	.18	.75	.82	
		.93	.07			.06			.94	
		.93	.07			.05			.94	
		.93	.07			.05			.95	
	801019.1500	.91	.69	.93	.07	.05	.06	.86	.94	
		.91	.09			.29			.71	
		.94	.06			.29			.71	
		.90	.10			.26			.74	
		.92	.08			.28			.72	
	810121.1000	.93	.67			.26			.72	
		.84	.16			.05			.95	
		.76	.24			.05			.95	
		.70	.39			.05			.94	
	810504.1045	.87	.13	.77	.23	.04	.05	.82	.95	
		.92	.08			.04			.96	
		.71	.29			.06			.94	
		.81	.19			.05			.95	
	810527.1010	.87	.13	.80	.20	.04	.05	.83	.95	
		.86	.14			.02			.98	
		.58	.42			.07			.93	
		.48	.52			.08			.92	
	810624.0940	.93	.67	.57	.43	.06	.06	.88	.94	
		.92	.08			.09			.91	
		.91	.09			.16			.84	
		.97	.03			.10			.98	
	810728.0900	.93	.67			.11			.82	

	VERNON CRK below H.W. (.50 00' 13' / N 119 23' 16' / W)				PHOSPHORUS		
DATE/TIME	TP	DP	DP/TP	SRP	SRP/TP	PP	PP/
	17	9		7			
	18	10		6			
	17	10		6			
	17	10	.56	6	.37	.66	.8
	17	10		7			.44
	17	10		7			
	18	12		7			
	17	10		7			
	17	11	.62	7	.40	.66	.7
	17	11		7			.38
	64	20		12			
	53	29		12			
	56	21		12			
	56	20	.35	12	.21	.59	.37
	810527.1110	58					.65
	21	14		9			
	21	15		9			
	21	14		10			
	21	14	.68	9	.44	.65	.7
	21	14		9			.32
	24	18		15			
	25	18					
	25	18		14			
	25	18	.73	15	.59	.81	.7
	810728.0935	25					.27

DATE/TIME	VERNON CRK below H.W. C50	TH	TDN	PN	NO3	NO2	N+N	NH4	DIN	NITROGEN		
										13°N	119°W	
800909.1325	367	343	44	26	44	26	1	21	3	24	326	.467
		335		17	17	18	1	18	9	27	308	
		345		32	32	34	2	34	2	36	309	
		350		23	23	24	1	24	5	29	314	.467
810121.1050	296	276	25	57	57	58	1	58	5	63	197	.432
		265		29	59	60	1	60	4	64	201	.504
		285		25	59	60	1	60	20	60	205	.462
		368		26	58	59	1	59	10	69	201	.466
810527.1110	434	388	54	10	10	12	3	12	3	15	375	.808
		390		11	11	14	3	14	1	15	345	.706
		368		14	14	16	2	16	2	16	364	.757
		390		12	12	14	2	14	2	16		
810624.1025	304	277	27	6	6	7	4	7	4	11	261	.278
		279		27	27	27	2	27	4	1	5	.258
		289		3	3	2	2	2	5	1	6	.274
		332		4	4	5	2	5	2	2	7	.268
810728.0935	421	386	35	14	14	12	1	12	1	13	319	.415
		393		21	21	23	1	23	1	24	369	.46
		433		9	9	12	0	12	0	15	418	
		386		35	14	16	2	16	2	17	369	.46

DATE/TIME	TIN/TN	PN/TN	NN/DIN	RN/DIN	DIN/TN	DON/DIN	DON/TN	NITROGEN RATIOS	
								16/N	16/W
800909, 1325	.89	.11	.84	.16	.07	.06	.81	.92	11
810121, 1050	.91	.09	.86	.14	.23	.26	.68	.74	18
810527, 1110	.88	.12	.88	.13	.04	.04	.84	.96	14
810624, 1025	.91	.09	.73	.27	.02	.03	.89	.97	10
810728, 0935	.92	.08	.90	.10	.04	.04	.88	.96	12

DATE/TIME	CRK C50 03/08/N	119 24/18/W)	GENERAL	PHYS/CHEM
	Temp C	C25	Turb WRI	WOB SiO2 C1
801019.1400	10.0	354.0	.44	22.5 7.2
801202.1315	4.0	521.0	.70	22.4 7.2
810120.1115	6.8	490.0	.52	22.5 6.9
810504.1100	9.3	504.0	13.00	6.20 22.0 7.5
810527.0903	10.9	515.0	2.20	1.30 22.5 7.0
810624.1325	13.4	457.0	2.10	22.4 6.5
810728.0805	12.3	458.0	3.70	22.8 6.9

DATE/TIME	WINFIELD TP	CRK C50	03/68/N	119	24/18/W	PHOSPHORUS		PP	FP/TP
						SRP	SRP/TP	SRP/DP	
801019.1400	31	25		23					
	30	25		23					
	31	25	.82	23	.75		.92	6	.18
	32	25		26					
	37	22		30					
	38	22		30					
	39	32	.85	30	.89		.94	6	.15
801202.1315	38	32		30					
	40	38		30					
	40	38		32					
	40	51		33					
810120.1115	40	50	.76	32	.79		1.04	10	.24
	74	29		29					
	78	29		29					
	72	29		29					
810504.1100	75	29	.39	29	.39		1.00	46	.61
	31	21		19					
	30	22		19					
	30	22		20					
810527.0903	30	22	.71	19	.64		.69	9	.29
	32	21		23					
	32	21		24					
	30	22		25					
810624.1325	31	21	.68	24	.77		1.13	10	.32
	41	27		26					
	40	28		26					
	40	27		26					
810728.0805	40	27	.68	26	.70		1.04	13	.32

DATE/TIME	TDN/TN	PN/TN	NN/DIN	AN/DIN	DIN/TN	NITROGEN RATIOS	
						DIN/DN	DN/TN
801019.1400	.98	.98	.98	.98	.92	.98	.98
	1.00	1.00	1.00	1.00	.98	.92	.92
	1.00	1.00	1.00	1.00	.94	.96	.96
	1.00	1.00	1.00	1.00	.95	.95	.95
801202.1315	.99	.01	.99	.01	.97	.93	.97
	.99	.99	.99	.99	.98	.92	.92
	.99	.99	.99	.99	.97	.93	.93
	.99	.99	.99	.99	.99	.91	.91
810120.1115	.98	.02	.99	.01	.97	.98	.98
	.98	.98	.98	.98	.92	.94	.94
	.98	.98	.98	.98	.92	.91	.91
	.98	.98	.98	.98	.86	.89	.89
810504.1100	.94	.06	.98	.02	.92	.91	.91
	.98	.98	.98	.98	.92	.93	.93
	.98	.98	.98	.98	.91	.96	.96
	.98	.98	.98	.98	.91	.95	.95
810527.0903	.98	.02	.99	.01	.93	.95	.95
	.98	.98	.99	.99	.92	.96	.96
	.98	.98	.99	.99	.90	.97	.97
	.98	.98	.99	.99	.90	.96	.96
810624.1325	.98	.02	.98	.00	.94	.95	.95
	.98	.98	.98	.98	.92	.97	.97
	.98	.98	.98	.98	.92	.98	.98
	.98	.98	.98	.98	.92	.98	.98
810728.0805	.98	.02	.98	.02	.95	.97	.97
	.98	.98	.98	.98	.92	.93	.93

DATE/TIME	MISSION CRK	C49	50°34'N	119°29'W	GENERAL PHYS/CHEM	C1	
	Temp C	C25	Turb	NWRI	Turb	WQB	SiO2
800910.0845	11.0	171.0			.53	11.5	.9
801019.1545	10.0	145.0			.56	10.9	1.2
810122.0943	2.3	232.0			.37	14.7	1.7
810502.1145	4.0	169.0			7.00	25.0	.7
810527.1320	8.5	53.2			50.00	19.00	11.6
810625.1035	11.3	61.0			3.10		12.5
810730.0915	13.5	101.0			1.90		14.6

DATE/TIME	MISSION	CRK (49°50'34"E N 119°29'10"E W)			PHOSPHORUS			PP	PP/TP
		TP	DP	DP/TP	SRP	SRP/TP	SRP/DP		
800910.0845		10	5		3	3			
		12	7		6	6			
		12	7		6	6			
		12	7	.56	6	.56			
		14	9		8	8			
		14	10		7	7			
		14	10		6.9	6	.55		
		14	10		6.9	6	.55		
801019.1545		74	28		12	12			
		72	28		8	8			
		71	28		8	8			
		72	28		9	9			
810122.0943		74	28		12	12			
		72	28		8	8			
		71	28		8	8			
		72	28		9	9			
810502.1145		74	28		12	12			
		72	28		8	8			
		71	28		9	9			
		72	28		9	9			
810527.1320		184	11		7	7			
		200	11		9	9			
		255	12		9	9			
		213	12	.05	8	.04			
		213	12	.05	8	.04			
810625.1035		18	9		6	6			
		19	9		6	6			
		17	9	.56	6	.35			
		18	9	.56	6	.35			
		14	8		7	7			
		15	8		7	7			
		17	9		7	7			
		15	8	.54	7	.46			
810730.0915		14	8		7	7			
		15	8		7	7			
		17	9		7	7			
		15	8		7	7			

DATE/TIME	MISSION	CRK	49°50'34"N			29°10'34"W			NITROGEN			PC
			TN	TIN	PN	NO3	NO2	N+H	NH4	DIN	DON	
800910.0845	248	235	18	73	1	74	6	82	153	.243		
		225		74	1	75	6	81	144			
		239	18	74	1	75	7	82	149	.243		
801019.1545	346	339	37	87	3	90	39	129	201	.329		
		295	42	64	3	87	38	117	178	.344		
		300	34	64	3	87	31	118	182	.284		
		308	38	65	3	88	33	121	187	.319		
810122.0943	487	535	10	357	3	360	40	400	135	.285		
		450	7	368	2	310	24	334	116	.271		
		450	10	296	4	300	26	326	124	.273		
		478	9	320	3	323	30	353	125	.276		
						97	5	102		1.173		
						111	68	91	2	93	197	1.604
						290	90	92	2	94	186	
						280						
810502.1145	396	285	111	92	3	95	2	97	188	1.389		
						230	52	14	2	16	214	1.000
						250	47	14	2	32	48	.977
						230	50	12	3	15	19	
						286	50	13	2	15	18	.989
810527.1320	286	185	22	20	3	23	1	24	161	.289		
		194	26	20	1	21	1	22	172	.286		
		176	18	2	20	1	21	1	21	155		
		185	24	19	2	21	1	22	163	.288		
810625.1035	209	268	16	22	2	24	28	52	216	.251		
			18	24	2	26	31	57				
		235		17	2	19	27	46	189			
810730.0915	269	252	17	21	2	23	29	52	206	.262		

DATE/TIME	LAMBLY CRK	C49	55°42'N	119°30'W	GENERAL	PHYS/CHEM
	Temp C	C25	Turb	NH4I	Turb	SiO2
					MDB	C1
800910.0915	10.0	205.0			.32	18.3
						.7
810122.1030	2.2	180.0			.25	18.0
						.7
810502.1030	4.0	78.4	30.00	7.80	15.7	.9
810527.1400	9.7	78.6	5.00	1.50	15.1	.7
810625.1420	10.8	108.0	1.60		17.8	.5
810730.0955	13.0	140.0	1.20		18.8	.5

		LAMBLY	CRK	(49°55'42"E N TP IP DP/TP SRP SRP/TP SRP/DP PP PP/TP					
DATE/TIME									
800910.0915	9	10	9						
	9	8	9	1.00	9	1.00	1.00	0	0.00
	12	12	9						
	12	10	9						
	13	10	9						
810122.1030	12	11	86		9	.73	.84	2	.14
	84	22	12						
	81	22	12						
	97	22	13						
810502.1030	87	22	.25		12	.14	.56	.65	.75
	25	9	7						
	21	9	7						
	24	8	7						
810527.1400	23	8	.36		7	.30	.84	15	.64
	14	10	8						
	15	11	9						
	15	10	10						
810625.1120	15	10	.70		9	.61	.87	4	.38
	15	11	11						
	14	11	11						
	14	13	11						
810730.0955	14	12	.81		11	.77	.94	3	.19

DATE/TIME	TH	TIN	CRK (49 RN	55'42''N 119'30''W) NITROGEN				PC		
				N03	N02	N+N	NH4 + DIN			
8/08/91 0.0915	160	155	150	5	5	1	6	.14	136	.103
			160	7	1	6	2	10	150	.103
8/10/122.1030	158	148	155	6	1	7	5	12	143	.103
			140	10	41	2	43	14	57	.93
8/10/502.1030	441	330	140	10	42	1	43	17	60	.141
			330	107	16	4	20	5	25	.176
8/10/527.1400	287	253	340	114	16	6	19	5	24	.307
			320	111	11	7	18	5	23	.297
8/10/730.0955	239	222	330	111	14	5	19	5	24	.306
			255	29	2	2	4	1	5	.357
8/10/527.1400	287	253	250	39	6	2	8	1	2	.531
			174	52	8	1	1	1	2	.247
8/10/625.1120	213	175	172	24	8	1	1	2	172	.374
			180	38	2	1	3	1	4	.307
8/10/730.0955	239	222	230	18	4	1	5	1	6	.341
			200	15	4	1	5	0	13	.224
8/10/730.0955	239	222	237	17	4	1	5	0	8	.277
			222	17	4	1	5	4	9	.242
8/10/730.0955	239	222	200	15	4	1	5	0	8	.229
			237	17	4	1	5	4	9	.260

LAMBLY CRK		(49 55/42/N 119 30/40/W)		NITROGEN RATIOS	
DATE/TIME	T DIN/TH	NH/DIN	AN/DIN	DIN/TH	DON/DIN
800910.0915	.97	.03	.43	.57	.99
			.60	.20	.94
			.58	.42	.92
				.08	.89
				.41	.92
			.62	.38	.59
			.78	.22	.59
			.75	.25	.14
			.72	.28	.18
810122.1030	.94	.06	.80	.20	.92
			.79	.21	.93
			.78	.22	.93
			.79	.21	.93
				.05	.93
				.07	.93
810502.1030	.75	.25	.80	.20	.98
				.02	.98
				.01	.99
			.50	.50	.98
			.81	.19	.98
				.02	.98
810527.1400	.88	.12	.50	.50	.99
			.83	.17	.97
			.38	.62	.94
			.50	.50	.97
			.75	.25	.98
			.75	.38	.98
810625.1120	.82	.18	.63	.38	.99
				.01	.99
				.02	.98
				.81	.98
					.97
					.94
					.96
810730.0955	.93	.07	.56	.44	.89
				.04	.94

DATE/TIME	TROUT CRK C49	34°/05'N	119°37'50"E(W)	GENERAL PHYS/CHEM	C1
	Temp C	C25	Turb NWR	Turb WQB	SiO2
800910.1040	15.5	605.0		4.36	16.6
					5.1
810122.1112	2.2	203.0		.67	15.0
					1.5
810430.0805	7.5	121.0	55.00	31.00	15.7
					1.1
810528.0610	9.5	66.0	26.00	7.40	14.1
					.9
810626.0905	13.2	75.0	10.20		15.8
					.7
810730.1105	15.8	110.0		5.40	
					.5

DATE/TIME	TROUT	CRK	34°/05'N			37°/58'W			PHOSPHORUS		
			DP	TP	DP/TP	SRP	TP	SRP/TP	SRP/DP	PP	PP/TP
800910.1040	11	3				3					
	12	4				4					
810122.1112	67	5				6					
	71	6				5					
810430.0805	68	6				5					
	245	8				6					
810528.0810	265	8				4					
	186	8				4					
810626.0905	232	8				5					
	89	8				6					
810730.1105	113	9				4					
	94	9				4					
	99	9				5					
	33	7				4					
	31	7				4					
	28	7				4					
	31	7				4					
	15					6					
	14	5				4					
	14	5				3					
	14	5				4					
	35					4					
	30					3					
	37					4					
	24					6					
	77					4					
	87					3					
	9					4					
	65					5					

DATE/TIME	TH	TDN	CRK	NITROGEN				DON	PC
				49	34	05	N		
800910, 1040	3229	3200	395	100	257	0	260	8	268
				355	100	237	240	9	249
810122, 1112	486	386	396	100	247	3	250	16	266
				386	100	247	250	11	261
810430, 0805	371	272	276	111	39	1	31	17	48
				246	87	31	32	33	44
810528, 0810	307	266	266	30	7	2	9	10	222
				266	44	11	14	15	196
810626, 0905	306	262	288	37	9	0	11	8	249
				270	28	19	21	9	249
810730, 1105	298	285	282	26	18	2	20	7	255
				287	15	61	63	1	64
				287	11	64	65	5	217
						64	65	6	217
						63	64	3	31

TROUT CREEK (49°34'05" N 119°37'50" W) NITROGEN RATIOS
 DATE/TIME TDN/TN PH/TN NH₃/DIN AN/DIN DIN/TN DIN/ON DON/TN DON/DN PC/DN

	.99	.01	.23	.77	.16
8008910.1040	.99	.01	.76	.24	
	.99	.01	.50	.50	.16
	.97	.03	.68	.32	.12
	.96	.04	.70	.30	.18
	.94	.06	.68	.32	.15
810122.1112	.79	.21	.54	.25	.31
	.65	.35	.18	.82	.23
	.75	.25	.18	.82	.22
	.61	.39	.18	.82	
810430.0805	.73	.27	.34	.60	.82
	.47	.53	.07	.93	.32
	.58	.42	.07	.93	.24
810528.0810	.88	.12	.56	.81	.92
	.78	.22	.09	.91	.18
	.71	.29	.10	.90	.22
810626.0905	.92	.08	.74	.83	.90
	.98	.02	.23	.77	.24
	.93	.07	.24	.76	.25
810730.1105	.96	.04	.23	.73	.76
					.24

SHINGLE CRK @LUMB. YD.	C28/C48	N 119 36' 03" W	GENERAL	PHYS/CHEM		
DATE/TIME	Temp C	C25	Turb NWR1	Turb WQB	SiO2	C1
801020.1245	10.0	184.0	.85	15.6	2.4	
810122.1236	4.3	277.0	.25	16.2	2.6	
810430.1700	16.5	232.0	9.00	16.8	2.5	
810528.0930	7.3	75.4	95.00	38.00	13.2	1.1
810626.0835	11.5	100.0	8.50	14.9	.9	
810730.1235	17.5	168.0	4.50	16.8	1.3	

DATE/TIME	SHINGLE CRK @LUMB. YD.	TP	DP	DP/TP	SRP	SRP/TP	SRP/DP	PHOSPHORUS		PP	PP/TP
								W)	N		
801020, 1245	15	11			9						
	15	11			11						
	15	11			9						
810122, 1236	15	11	.73		10	.64		.88		4	.27
	19	14			11						
	19	13			12						
810430, 1700	19	14			11						
	19	14	.72		11	.60		.83		5	.28
	84	21			14						
810528, 0930	90	20			14						
	84	17			14						
	86	19	.22		14	.16		.72		67	.78
810626, 0835	446	23			14						
	480	25			15						
	385	23			15						
810730, 1235	435	24	.65		15	.63		.62		411	.95
	48	14			13						
	56	15			13						
810730, 1235	47	15	.29		12						
	50	15			13	.25		.86		36	.71
	33	18			16						
810730, 1235	32	17			16						
	31	18			16						
	32	18	.55		16	.50		.91		14	.45

DATE/TIME	SHINGLE CREEK	COLUMN	YD. (49' 28" N 48' 03" W)	NITROGEN						PC	
				TN	TDN	PN	N03	N02	N+N	NH4	
801020.1245	202	187	149	1.4	0	1	1	1	2	193	.191
			185	1.2	0	1	1	1	1	2	.176
			189	1.9	0	1	1	1	1	2	.209
			187	1.5	0	1	1	1	1	2	.190
810122.1236	283	258	240	2.5	1.07	2	1.09	1.15	1.24	1.16	.269
			265	2.5	1.11	2	1.13	1.9	1.22	1.43	.231
			270	2.5	1.05	2	1.07	1.5	1.12	1.56	.189
			258	2.5	1.08	2	1.10	1.0	1.19	1.39	.230
810430.1700	452	278	295	1.68	6	2	8	1	9	286	1.788
			286	1.80	2	3	5	1	6	274	2.068
			260	1.60	4	2	6	1	7	253	
			285	1.71	1.9	3	2.2	1	2.3	262	3.910
			270	2.95	1.0	2	1.2	1	1.3	257	4.650
			270	2.95	1.9	3	2.2	1	2.3	271	1.928
810528.0930	506	275	233	1.6	3	1.9	1	1	2.0	255	4.280
			294	4.8	1.8	2	2.0	1	2.1	183	.564
			218	5.4	4	4	4	1	1	22	.928
810626.0835	262	211	51	1.8	3	2.1	1	1	2.2	189	.746
			316	2.9	1.0	1	1.1	3	1.4	302	.338
			330	1.6	1.8	2	2.0	1	1.1	309	.256
810730.1235	346	323	23	1.2	1	1.4	2	1.5	1.5	308	.297

DATE/TIME	SHINGLE CRK @LUMB. YD.	NITROGEN RATIOS						
		TDN/TN	NH ₃ /TN	NH ₄ /DIN	DIN/TN	DIN/DN	DON/TN	DON/DN
801020, 1245	.93	.07	.50	.50	.01	.01	.99	14
			.50	.50	.01	.01	.99	14
			.50	.50	.01	.01	.99	11
			.50	.50	.01	.01	.99	13
810122, 1236	.91	.09	.88	.12	.52	.46	.46	11
			.93	.07	.46	.41	.54	9
			.96	.04	.46	.41	.59	8
			.92	.06	.42	.46	.54	9
810430, 1700	.62	.38	.89	.11	.03	.03	.97	11
			.83	.17	.02	.02	.96	11
			.86	.14	.03	.03	.97	11
			.86	.14	.02	.03	.97	11
810528, 0930	.54	.46	.96	.04	.08	.08	.92	23
			.92	.08	.05	.05	.95	16
			.95	.05	.07	.07	.93	18
			.95	.05	.10	.10	.90	12
810626, 0835	.81	.19	.95	.05	.08	.10	.72	15
			.79	.21	.04	.04	.96	12
			.95	.05	.06	.06	.94	16
			.91	.09	.04	.05	.89	13
810730, 1235	.93	.07	.89	.11				

DATE/TIME	Temp C	C25	Turb NURI	Turb WOB	SiO2	PHYS/CHEM C1
800911.0000	21.0	177.0		.47	13.1	2.1
810122.1405	4.0	135.0		.26	17.5	.7
810501.1655	6.8	45.0	24.00	7.50	13.6	.9
810528.1110	9.2	38.2	9.80	3.70	13.1	.6
810625.1510	16.0	45.0	1.90		15.6	.6
810730.1410	18.2	65.0	1.20		16.7	.5

DATE/TIME	CRK#	HIWAY	97(49 14'42''N 119 31'25''W)	PHOSPHORUS			PP/PP
				DP	TP	SRP/TP	
800911.0000	4	2	3	3	3	1.50	3 .56
	5	2	3	3	3	1.50	
	5	2	.44	3	.67		
	7	5	5	5	5		
	7	5	5	5	5		
	7	5	.71	5	.71	1.00	2 .29
810122.1405	88	19	8	7	7		
	67	20	7	7	7		
	69	20	7	7	7		
	68	20	.22	7	.08		
	23	6	4	4	4		
	23	7	3	3	3		
	27	7	4	4	4		
	24	7	.27	4	.15		
810528.1110	10	7	3	3	3		
	10	7	3	3	3		
	11	7	3	3	3		
	10	7	.68	3	.29		
810625.1510	9	9	4.3	3	.43		.32
	9	9					
810730.1410	7	7					.28

DATE/TIME	WATER COURSE	HIGHWAY	97(49	14'42"	N	119	31'25"	W	NITROGEN			PC		
									NO3	NO2	N+H	NH4	DIN	DON
800911.0000	295	276	25	3	1	4	30	34	221	218				
			255	3	1	4	16	20	265					
			285	3	1	4	23	27	243	218				
810122.1405	128	118	10	0	1	1	6	7	88	138				
			95	10	0	1	6	7	11	106	110			
			140	10	5	1	6	8	14	126	119			
			140	10	5	1	6	7	11	106	122			
810501.1655	366	309	65	74	0	1	6	9	14	286	1108			
		309	69	69	5	2	7	6	12	288				
		297	69	69	5	2	7	6	15	281	1136			
810528.1110	247	220	15	5	1	0	7	3	10	210	1164			
		245	15	5	1	0	7	5	12	218	296			
		239	15	4	0	0	7	4	10	222	296			
		232	15	3	0	0	6	4	10					
		227	11	3	0	0	6	12	18	209	135			
		238	11	2	0	0	4	1	5	233	109			
		241	0	0	0	0	4	1	15	226				
		235	11	0	0	0	5	6	13	223	122			
810625.1510	246	235	11	0	0	0	4	12	16	191	125			
		207	13	0	0	0	1	1	6	11	152			
		218	18	4	0	0	1	1	7	191				
		198	16	4	1	0	1	1	8	11	196	139		
810730.1410	223	208	16	0	0	0	0	0	0					

DATE/TIME	CRK@ HIWAY 97(49 14'42''N 119 31'25''W)	NITROGEN RATIOS
	TIN/TN PN/TH NH/DIN RH/DIN DIN/TN DIN/DN DON/TN DON/DN PC/F	
800911.0000	.92 .68 .15 .85 .09 .10 .82 .90 .93	.12 .88 .86 .80 .07 .13 .87 .9
		.26 .86 .85 .85 .10 .82 .90 .93
		.14 .86 .86 .86 .07 .07 .93 .14
810122.1405	.92 .68 .38 .62 .69 .10 .83 .90 .93	.43 .57 .57 .57 .10 .10 .90 .12
		.45 .55 .55 .55 .07 .07 .90 .18
		.36 .64 .64 .64 .05 .05 .95 .15
810501.1655	.81 .19 .43 .57 .64 .05 .77 .77 .95	.50 .58 .58 .58 .04 .04 .96 .16
		.70 .38 .38 .38 .05 .05 .95 .20
810528.1110	.94 .66 .59 .41 .41 .04 .90 .90 .95	.58 .42 .42 .42 .05 .05 .95 .20
		.33 .67 .67 .67 .08 .08 .92 .12
		.89 .29 .29 .29 .02 .02 .98 .10
810625.1510	.96 .64 .37 .63 .63 .05 .90 .90 .95	.27 .73 .73 .73 .06 .06 .94 .11
		.25 .75 .75 .75 .08 .08 .92 .10
		.45 .55 .55 .55 .05 .05 .95 .08
810730.1410	.93 .67 .32 .68 .68 .05 .88 .88 .95	.29 .71 .71 .71 .04 .04 .96 .09
		.25 .75 .75 .75 .08 .08 .92 .09

DATE/TIME	CRK #	WOOD LAKE	(50' 03' 08' N 119 24' 15' W)			PHOSPHORUS		
			TP	DP	SRP/TP	SRP	SRP/DP	PP
800528.0000	67	26			14			
	67	22			14			
	64	20			14			
	66	23	.34	.14	.21	.62	.43	.66
800909.1050	95	68						
	98	66			.54			
	98	64			.54			
	97	66	.68		.54			
	54	27			17			
	55	26			17			
	58	28			16			
	56	27	.49		17			
801019.1415	98	19			11			
	98	19			14			
	57	20			13			
	38	19	.51		13			
801202.1307	49	13			5			
	49	13			3			
	49	13			4			
	49	13	.27		4			
810120.1107	49	13			.08			
	158	22						
	159	20			17			
	170	22			17			
	160	21	.13		17			
810504.0930	169	26			18			
	179	27			18			
	167	29			17			
	172	27	.16		18			
810527.0940	79	19						
	81	11						
	77	10						
	79	10	.13					
810624.1350	78	26						
	82	26						
	77	28						
	79	27	.34					
810728.0825	78	26						
	82	26						
	77	28						
	79	27	.21					

DATE/TIME	VERNON CRK @ WOOD LAKE	(50' 03' 08' N 119° 24' 15" W)				NITROGEN		r _c
		TDN	TN	PH	H03	H02	N+H	NH4
863		481	9	499	32	522	341	
878		482	8	496	30	520	358	
848		492	8	500	29	529	319	
863		485	8	493	30	524	339	
800528.0000								
	2300	115	1658	162	1820	14	1834	466
	2650		1718	162	1880	43	1923	727
	2460		1628	162	1790	15	1805	655
	2470	115	1668	162	1830	24	1854	616
								1.050
800909.1050								
	870	159	474	6	480	1	481	389
	905	160	464	6	470	1	471	434
	895	165	474	6	480	1	481	414
	890	161	471	6	477	1	478	412
								1.110
801019.1415								
	810	50	596	4	600	14	614	196
	820	50	596	4	600	16	616	204
	840	55	586	4	590	20	610	230
	823	52	593	4	597	17	613	210
								.580
801202.1307								
	875							
	695	121	456	4	460	16	476	219
	705	142	446	4	450	24	474	231
	720	150	456	4	460	17	477	243
	707	138	453	4	457	19	476	231
								.919
810120.1107								
	844							
	490	308	194	5	199	1	200	290
	500	293	194	5	199	1	200	300
	510		195	5	200	12	212	298
	500	300	194	5	199	5	204	296
								2.584
810504.0930								
	800							
	380	161	37	2	39	26	65	315
	370	164	35	2	37	3	40	330
	410		37	3	40	57	97	313
	387	163	36	2	39	29	67	319
								1.790
810527.0940								
	549							
	384	386	76	3	79	24	103	281
	418	392	86	2	88	50	138	280
	472		84	3	87	68	155	317
	425	389	82	3	85	47	132	293
								2.060
810624.1350								
	814							
	690	149	318	7	325	1	326	364
	750	147	311	9	320	5	325	425
	745		303	7	316	16	326	419
	728	148	311	8	318	7	326	403
								1.221
810728.0825								
	876							

DATE/TIME	VERNON CRK @ WOOD LAKE	(50.03/08/84)	119.24/15.40	NITROGEN RATIOS
	TDN/TN	PN/TN	NN/DIN	DIN/TN DIN/DN DON/DN PC/DN
800528.0000	.94	.96	.60	.40
	.94	.96	.59	.41
	.95	.95	.62	.38
	.94	.96	.61	.39
	.99	.91	.80	.20
	.98	.92	.73	.27
	.99	.91	.73	.27
	.99	.91	.75	.25
800909.1050	.96	.94	.72	.24
	.99	.91	.75	.25
	1.00	0.99	.55	.45
	1.00	0.99	.52	.48
	1.00	0.99	.54	.46
	1.00	0.99	.54	.46
801019.1415	.85	.15	.45	.39
	.98	.92	.76	.24
	.97	.93	.75	.25
	.97	.93	.73	.27
	.97	.93	.74	.24
	.97	.93	.68	.32
	.95	.95	.67	.33
	.96	.94	.66	.34
	.96	.94	.67	.27
801202.1307	.94	.06		
	.97	.93	.68	.32
	.95	.95	.67	.33
	.96	.94	.66	.34
	.96	.94	.67	.27
810120.1107	.84	.16		
	.97	.93	.68	.32
	.95	.95	.67	.33
	.96	.94	.66	.34
	.96	.94	.67	.27
810504.0930	.62	.38		
	.98	.91	.41	.59
	.94	.96	.40	.60
	.94	.96	.42	.58
	.98	.92	.41	.59
	.98	.92	.37	.59
810527.0940	.70	.30		
	.69	.49	.17	.83
	.93	.68	.11	.89
	.41	.59	.24	.76
	.41	.59	.17	.83
	.57	.43	.12	.31
	.77	.23	.27	.73
	.64	.36	.33	.67
	.56	.44	.33	.67
	.64	.36	.16	.69
810624.1350	.52	.48		
	1.00	0.00	.47	.53
	.98	.02	.43	.57
	.95	.05	.44	.56
	.98	.02	.37	.46
810728.0826	.83	.17		

VERNON CRK @ WOOD LAKE (50° 03' 08" N 119° 24' 15" W) GENERAL PHYS/CHEM

DATE/TIME Temp C C25 Turb NRI Turb NQB S102 C1

13.8

13.8

19.1

15.6

3.70

219.0

800969.1656 12.6 303.0

1.60

19.0

5.1

801019.1415 10.5 515.0

5.00

18.1

2.7

801202.1307 .2 255.0

4.00

17.1

2.8

810120.1107 2.8 216.0

1.30

15.9

3.0

810504.0930 10.0 160.0

40.00

24.00

14.6

2.0

810527.0940 15.7 106.0

38.00

15.00

12.9

1.1

810624.1350 17.5 101.0

25.00

13.4

1.2

810728.0825 20.8 137.0

13.50

14.4

1.8

VERNON ČÍK 00KAN: LAN. (50 14'50" N 119 20'35" W) GENERAL PHYS/CHEM
DATE/TIME Temp. C F25 Turb NMRB Turb WQB SiO2 C1

800527.0000	538.0	5.30	11.6		
800908.1400	16.0	590.0	.83	13.0	8.2
801019.1130		173.0	.68	12.4	7.3
810121.0953	3.5	516.0	.45	12.5	6.7
810503.1115	10.1	419.0	14.00	7.50	10.0
810526.1020	12.9	412.0	26.00	6.80	9.7
810623.1355	16.0	366.0	10.00		8.9
810727.1440	22.8	387.0	34.00		9.2
					3.0

DATE/TIME	VERNON CRK @OKAHN, LAN.	50°14'50"S DP/TP	1119 26/35/W SRP/TP	PHOSPHORUS PP	PP/TP
800527.0000	60 36	31			
	64 37	31			
	68 39	31			
	64 37 .58	.48			
	43 35	35			
	42 35	35			
	42 35	.34			
	800908.1400	.83			
	42 35	.35			
	26 22	20			
	26 21	20			
	26 21	20			
	801019.1130	.82			
	26 21	.77			
	41 20	21			
	39 20	20			
	39 20	20			
	810121.0953	.50			
	40 20	.51			
	53 14	12			
	59 13	11			
	52 13	11			
	810503.1115	.26			
	52 13	.22			
	69 18	17			
	62 18	16			
	810526.1020	.27			
	66 18	.25			
	30 11	12			
	33 10	11			
	31 10	10			
	810623.1355	.33			
	31 10	.35			
	66 16	19			
	67 15	17			
	67 15	16			
	810727.1440	.23			
	67 15	17			

DATE/TIME	VERNON CRK	TH	TDN	PH	LAH.				20/35/ ^W N				119 NITROGEN			
					NH3	NO2	NH4	N+H	DIN	TDN	NH4	DIN	TDN	NH4	N+H	DIN
8/00527.0006					737	373	7	380	21	401	336					
					727	363	7	370	21	391	336					
					742	374	6	380	25	405	337					
					735	376	7	377	22	399	336					
					740	27	471	9	480	9	489	251				
					695	429	1	430	15	445	250					
					739				460	10	470	260				
					800908.1400	749	27	452	5	457	11	468	254			
					670	36	425	5	430	3	433	237				
					700	33	436	4	440	7	447	253				
					700	28	434	6	440	5	445	255				
					801019.1130	720	30	432	5	437	5	442	248			
					705	51	435	5	440	21	461	244				
					670	49	435	5	440	16	456	214				
					685	54	445	5	450	19	469	216				
					810121.0953	738	51	438	5	443	19	462	225			
					390	112	122	6	128	6	134	256				
						117	123	5	128	6						
						415		3		8						
					810503.1115	517	403	114	123	5	128	7	135	268		
						335	94	67	4	71	2	73	262			
						320	106	74	3	77	7	84	236			
					810526.1020	428	328	100	73	3	82	5	81	246		
						287	44	46	3	49	1	50	237			
						285	53	48	2	50	1	51	234			
					810623.1355	339	290	49	48	2	50	12	64	234		
						410	102	89	3	92	1	93	317			
						355	111	93	3	96	1	97	258			
						405							308			
					810727.1440	497	390	107					96			

VERNON CRK @OKAN, LAN. (50°14'50"N 119°20'35"W) NITROGEN RATIOS
 DATE/TIME TDN/TN FN/TN NH/DIN AN/DIN DIN/TN DIN/DN DON/TN DON/DN PC/PH

	.95	.05	.54	.46
	.95	.05	.54	.46
	.94	.06	.55	.45
	.94	.06	.54	.46
800527.0000				
	.98	.02	.66	.34
	.97	.03	.64	.36
	.98	.02	.64	.36
800908.1400	.96	.04	.63	.35
	.99	.01	.65	.35
	.98	.02	.64	.36
	.99	.01	.64	.36
801019.1130	.96	.04	.61	.34
	.95	.05	.65	.35
	.96	.04	.68	.32
	.96	.04	.68	.32
810121.0953	.93	.07	.63	.30
	.96	.04	.67	.33
			.34	.37
810503.1115	.78	.22	.95	.26
	.97	.03	.34	.52
	.92	.08	.22	.66
			.26	.12
810526.1020	.77	.23	.94	.06
	.98	.02	.19	.25
	.98	.02	.17	.22
	.81	.19	.18	.26
810623.1355	.86	.14	.92	.08
	.81	.19	.21	.26
	.92	.08	.19	.69
			.23	.81
810727.1440	.79	.21	.99	.01
	.99	.01	.23	.77
	.99	.01	.27	.73
	.99	.01	.24	.76
			.25	.59
			.25	.75

16 SKAHA LAKE INLET (49°27'20" N 119°35'45" W) GENERAL PHYS/CHEM
 DATE/TIME Temp C C25 Turb HWTI Turb WOB S102 C1

 800910,1300 18.0 267.0 .68 4.7 2.7

 810122,1300 4.2 266.0 .23 5.6 2.5

 810506,1010 7.5 195.0 5.20 2.50 10.3 2.2

 810528,1000 13.4 218.0 48.00 12.00 6.9 1.5

 810626,0755 15.0 230.0 1.20 4.9 1.4

 810730,1300 20.6 245.0 2.60 4.9 4.9

DATE/TIME	SKAHA LAKE INLET (49°27'N 119°35'W)			PHOSPHORUS		
	TP	DP	DP/TP	SRP	SRP/TP	PP
800916.1300	12	5	4	4	.33	.58
	12	5	4	4	.80	7
	12	5	.42	4		
	17	10	7	7		
	17	9	7	7		
	17	9	7	7		
	17	9	.55	7		
810122.1300	17	9	.55	7	.41	.45
	43	19	11	11		
	41	18	11	10		
	41	18	11	10		
	42	18	11	11	.26	.56
810506.1010	42	18	11	11	.58	23
	235	6	6	6		
	310	7	5	5		
	270	8	6	6		
	272	7	.63	6	.02	.81
810528.1000	272	7	.63	6		
	9	8	8	8		
	9	8	8	8		
	9	8	8	8		
	9	8	8	8		
810626.0755	9	8	.30	8	.33	1.13
	15	6	7	7		
	15	5	6	6		
	16	6	6	6		
	16	6	.37	6	.41	1.12
810730.1300	15	6				
	15	6				

DATE/TIME	SKAHA LAKE TN	INLET(49°27'20"E N 35°45'45"W)	NITROGEN						PC	
			TDN	PN	N03	N02	N+N	NH4	DIN	
800910, 1300	522	485	32	16	4	20	125	145	34.0	.377
		495	32	17	4	21	124	145	35.0	
		496	32	17	4	21	125	145	34.5	.377
810122, 1300	407	390	19	50	0	53	182	235	15.5	.248
		390	19	48	0	51	184	235	15.5	
		385	19	49	0	52	186	238	14.7	
810506, 1010	471	388	19	49	0	52	184	236	15.2	.248
		410	55	18	7	25	188	213	19.7	.501
		430	57	19	6	25	183	209	22.2	.544
		465	56	19	6	25	186	211	19.4	
		415	56	19	6	25	186	211	20.4	.523
		280	183	8	4	12	76	88	19.2	.050
		245	221	6	4	8	66	74	17.1	.980
		263	203	6	0	0	0	0	0	
810626, 0755	192	466	175	20	8	4	12	38	13.7	.175
		154	28	7	4	11	7	18	13.6	.249
		174	24	7	4	11	12	23	15.1	
		168	24	7	4	11	15	26	14.1	.212
		266	38	84	6	90	42	132	13.4	.395
		324	34	86	6	92	38	130	19.4	.342
		312	36	86	5	91	34	125	18.7	
810730, 1300	337	361	36	85	6	91	38	129	17.2	

DATE/TIME		SKHHA LAKE INLET (49°27'28"E N 119°35'45"W)		NITROGEN RATIOS	
TDN/TH	PN/TH	NN/DIN	AN/DIN	DIN/TH	DON/TH
800910,1300	.94	.06	.14	.86	.39
			.14	.86	.29
			.14	.86	.71
			.14	.28	.66
			.23	.77	.60
			.22	.78	.60
			.22	.78	.62
			.22	.78	.61
810122,1300	.95	.05	.14	.58	.37
			.12	.88	.52
			.12	.88	.48
			.12	.88	.52
			.12	.88	.43
810506,1010	.68	.12	.12	.88	.31
			.14	.86	.49
			.11	.89	.36
			.14	.86	.69
810528,1000	.56	.44	.12	.88	.39
			.32	.68	.22
			.61	.39	.12
			.48	.52	.13
			.43	.57	.14
810626,0755	.87	.13	.43	.57	.16
			.68	.32	.58
			.71	.29	.49
			.73	.27	.49
810730,1300	.89	.11	.71	.29	.43
					.51
					.57
					.10
					.60
					.60
					.57
					.10

19

DATE/TIME	LAKE INLET	(49 05'21"N 119 32'05"W)	GENERAL	PHYS/CHEM		
	Temp C	C25	Turb	WQB		
		NWRI	Turb	SiO ₂		
			WQB	C1		
800911.0000	19.0	267.0	.53	3.3	2.2	
810422.1430	4.1	296.0	.23	4.8	2.5	
810501.1715	10.6	151.0	40.00	26.00	9.0	1.5
810528.1220	14.6	219.0	11.00	2.70	4.9	1.7
810625.1415	18.0	230.0	2.50		3.7	1.8
810730.1455	21.5	247.0	1.60		4.3	1.8

DATE/TIME	OSOVOOS	LAKE	INLET	C49 05/21/ ^W			N 119 32/05/ ^W			PHOSPHORUS		
				TP	DP	DP/TP	SRP	SRP/TP	SRP/DP	PP	PP/TP	PP/DP
				13	6		6					
				17	6		6					
800911.00000	15	6		.40			.40			1.00		.60
				27	12		8					
				26	10		8					
				26	12		8					
810122.1430	26	11		.43			.30			.71		.57
				93	19		11					
				95	19		11					
				94	18		11					
810501.1715	94	19		.20			.12			.59		.80
				39	6		5					
				45	7		4					
				52	7		.15					
810528.1220	45	7					.10					
				19	4		4					
				17	4		3					
				18	5		3					
810625.1415	18	4		.24			.19			.77		.76
				16	6		7					
				16	6		7					
				15	6		6					
810730.1455	16	6		.51			.47			.92		.49

DATE/TIME	OSOYOOOS LAKE INLET	49				05/21/N				119 32'W)				NITROGEN		PC	
		TN	TDN	PN	N03	N02	N+N	NH4	DIN	DON							
		365	41	64	4	68	10	78	287								.342
		355	66	4	70	8	78	277									
800911.0000	401	360	41	65	4	69	9	78	282								.342
		340	69	154	2	156	13	169	171								.519
		345	155	3	158	16	174	171									
		335	153	3	156	17	173	162									
810122.1430	409	348	69	154	3	157	15	172	168								.519
		360	142	81	7	88	4	92	268								.259
		380	111	90	4	94	14	108	272								.466
		335	127	80	7	87	7	86	255								
810501.1715	485	358	127														1.363
		240	90	14	2	16	7	23	217								.677
		235	60	15	1	16	13	29	206								.743
		250	13	2	15	10	25	225									
810528.1220	317	242	75	14	2	16	10	26	216								.710
		206	45	16	3	19	1	20	186								.351
		240	50	16	4	20	1	21	219								.352
		220	16	4	20												
810625.1415	270	222	48	16	4	20	1	21	201								.352
		207	38	42	1	43	4	47	160								.294
		242	35	39	1	40	6	46	196								.257
810730.1455	261	225	37	41	1	43	9	52									
									48	176							.276

OSOYOOS LAKE INLET (49°05'21"N 119°32'05"W) NITROGEN RATE

DATE/TIME TDN/TN PN/TH NH/DIN AN/DIN DIN/TH DON/TH PC/DN PC/PN

	.87	.13	.21	.79	8
	.90	.10	.22	.78	8
	.88	.12	.19	.78	8
	.92	.08	.50	.50	8
	.91	.09	.50	.50	8
	.90	.10	.52	.48	8
	.91	.09	.51	.49	8
	.96	.04	.26	.74	9
	.67	.13	.28	.72	13
	.98	.03	.24	.76	
	.93	.07	.19	.55	
810501.1715	.74	.26	.19	.74	11
	.70	.30	.10	.90	8
	.55	.45	.12	.88	12
	.60	.40	.10	.90	
	.61	.39	.08	.89	9
810528.1220	.76	.24	.11	.68	
	.95	.05	.10	.90	8
	.95	.05	.09	.91	7
810625.1415	.82	.18	.05	.75	7
	.91	.09	.23	.77	8
	.87	.13	.19	.81	7
	.83	.17			
	.87	.13	.22	.67	8
810730.1455	.86	.14	.19	.78	8

DUCK LAKE OUTLET (50° 00' 58" N 119° 24' 05" W) GENERAL PHYS/CHEM
 DATE/TIME Temp C C25 NWRI Turb WOB SiO₂ C1

 800909, 1430 19.0 162.0 3.60 15.4 1.1

 810121, 1200 2.9 149.0 1.50 14.6 1.2

 810504, 1200 10.6 135.0 25.00 14.00 14.0 1.2

 810527, 1140 16.7 99.8 12.00 6.60 12.7 1.9

 810624, 1245 17.5 90.0 22.50 13.2 .8

 810728, 1010 22.8 100.0 8.80 13.5 .9

DATE/TIME	DUCK LAKE OUTLET	60'58'N 119°24'05"E			PHOSPHORUS		PP/TF
		DP	TP	SRP	SRP/TP	SRP/DP	
	160			11			
	164	36		13			
	164	35		13			
	163	36	.22	12	.68	.55	.78
800909.1430							
	25	11		4			
	27	11		3			
	26	11		3			
	26	11	.42	3	.13	.30	.58
810121.1200							
	73	6		5			
	73	9		4			
	71	9		4			
	71	9	.12	4	.06	.50	.64
810504.1200							
	69	15		9			
	68	19		9			
	69	20		9			
	69	18	.26	9	.13	.48	.51
810527.1140							
	61	12		4			
	61	15		3			
	63	12		3			
	62	13	.21	3	.05	.26	.49
810624.1245							
	48	13		3			
	48	13		3			
	46	13		3			
	47	13	.27	3	.18	.64	.34
810728.1010							

DATE/TIME	DUCK LAKE TH	OUTLET PN TDN	<50' 60' 58' N						24' 05' <W)			NITROGEN			PC
			N02	N03	N02	N+N	NH4	DIN	NH4	DIN	DON	NH4	DIN	DON	
8606909, 1430	1500	763	6	4	10	680	690	810	5.650						
	1500		12	6	18	660	678	822							
	1700		28	6	34	720	754	946							
	1567	763	15	5	21	687	707	859	5.650						
810121, 1200	380	87	6	2	9	14	22	278	.823						
	265	105	5	2	7	8	15	250	.890						
	300	84	6	2	8	11	19	281	.809						
	288	92				11	19	270	.841						
810504, 1200	407	270	134	2	4	1	5	265	1.341						
	290	124	2	2	10	1	11	279	1.381						
	275		3	2	6	1	7	268							
	278	129	4	2	7	1	8	271	1.361						
810527, 1140	446	315	138	2	1	3	18	21	294	1.030					
	315	130	3	1	4	10	14	301	1.040						
	305		2	1	3	4	7	298							
	312	134	2	1	3	11	14	298	1.035						
810624, 1245	773	360	421	7	3	5	25	30	313	2.120					
		343		7	3	5	7	22	29	323					
	352	421													
810628, 1010	537	331	156	4	1	5	24	29	302	.960					
	399	179	4	1	5	6	13	377	1.075						
	387		4	0	7	6	13	374							
	369	168	4	2	6	13	18	351	1.018						

DUCK LAKE OUTLET (50° 00' N 119° 24' W) NITROGEN RATIOS
 DATE/TIME TDN/TN PN/TN NH₃/TN AN/DIN DIN/TN DIN/DN DON/TN DON/DN PC/PN

	.01	.99		.46		.54	7
	.03	.97		.45		.55	
	.05	.95		.44		.56	
	.03	.97	.30	.45	.37	.55	7
	.36	.64		.07		.93	9
	.47	.53		.06		.94	8
	.42	.58		.06		.94	10
	.41	.59	.05	.06	.71	.94	9
	.80	.20		.02		.98	10
	.91	.69		.04		.96	11
	.86	.14		.03		.97	
	.87	.13	.02	.03	.66	.97	11
	.14	.86		.07		.93	7
	.29	.71		.04		.96	8
	.43	.57		.02		.98	8
	.24	.76	.03	.04	.67	.96	8
							5
	.17	.83		.09		.91	
	.24	.76	.04	.08	.42	.92	5
	.17	.83		.09		.91	6
	.38	.62		.03		.97	6
	.54	.46		.03		.97	
	.31	.69	.03	.05	.65	.95	6

DATE/TIME	OVAMA CHANNEL	Temp C	C25	Turb MUR	Turb WOB	SiO ₂	C1	GENERAL PHYS/CHEM
8006909.1015	06/39/N	18.0	331.0		.64	1.0	3.8	
8010019.1330	06/39/W	5.4	643.0		.61	1.2	3.7	
801202.1330	06/39/N	5.4	262.0		.72	2.2	3.7	
810120.1130	06/39/W	2.0	328.0		.33	2.5	3.6	
810504.0900	06/39/N	8.0	328.0	1.50	1.20	1.1	3.9	
810527.0645	06/39/W	14.7	321.0	2.60	.75	1.0	3.6	
810624.1500	06/39/N	16.0	290.0	1.30		1.1	3.4	
810728.0735	06/39/W	22.0	288.0	1.20		1.7	3.2	

DATE/TIME	DOH/TH	CANAL	06/39/N	119/22/50/W	NITROGEN RATIOS
	PN/TH	NN/DIN	AN/DIN	DIN/TN	DIN/DN DON/TH DON/DN PC/PN
800909.1015	.86	.14	.48	.52	.05 .95 .06 .94 .06 .94 .06 .94 .05 .94 .05 .95
801019.1330	.76	.24	.31	.69	.03 .11 .26 .20 .21 .20 .26 .21 .24 .20 .19 .73
801202.1330	.92	.08	.76	.97	.03 .11 .92 .68 .96 .64 .95 .65 .97 .38
810120.1130	.97	.03	.95	.96	.04 .17 .95 .39 .95 .37 .95 .60
810504.0900	.88	.12	.84	.84	.16 .08 .95 .65 .84 .16 .87 .13 .87 .13
810527.0845	.91	.09	.75	.75	.25 .87 .54 .46 .46 .02
810624.1500	.84	.16	.38	.38	.63 .05 .43 .57 .57 .04
810728.0735	.92	.08	.48	.48	.62 .04 .38 .62 .61 .39

DATE/TIME	OYAMA CANAL	(50°06'39"N 119°22'50"E)				NITROGEN		DON	PC
		TN	TDN	PN	NO ₃	NO ₂	N+H ₄		
		415	69	8	1	9	13	22	.393 .729
		460		14	1	15	12	27	.433
		430		11	1	12	14	26	.404
		435	69	11	1	12	13	25	.410 .729
800909.1015	504								
		395	115	5	2	7	13	20	.375 1.150
		405	133	3	2	5	12	17	.388 1.376
		390	118	3	1	4	11	15	.375 1.266
		390	122	4	2	5	12	17	.379 1.266
801019.1330	519	397							
		385	35	48	10	58	20	78	.307 .387
		375	34	58	1	59	16	75	.300 .425
		375	29	56	1	57	20	77	.298 .407
		378	33	54	4	58	19	77	.302 .406
801202.1330	411								
		470	24	170	1	171	6	177	.293 .201
		480	12	172	1	173	16	189	.291 .206
		490	14	172	1	173	7	180	.310 .209
		480	17	171	1	172	16	182	.298 .205
810120.1130	497								
		360	49	34	3	37	7	44	.316 .386
		350	53	38	4	42	2	44	.306 .407
		375		42	4	46	6	55	
		375		38	4	42	6	48	.320 .397
810504.0900	413	362	51						
		410	39	3	5	8	7	10	.370 .493
		380	34	6	6	3	1	4	.321 .409
		325		1	2	3	5	4	
		325		1	3	5	4	9	.363 .451
810527.0845	408	372	37						
		350	70	5	1	6	10	16	.334 .496
		350	62	6	1	9			.420
		357		4	1	5	6	13	
		354	66	6	1	7	9	16	.338 .458
810624.1500	420								
		430	45	11	1	12	13	25	.405 .379
		476	39	13	1	14	23	37	.439 .323
		492		8	9	11	7	18	.474
810728.0735	508	466	42	11	2	12	14	27	.439 .351

KALAMALKA LAKE OUTLET (50 13'54"N 119 16'00"W) GENERAL PHYS/Chem
DATE/TIME Temp C C25 Turb MMRI Turb MQB S102 C1

800908.1500	19.0	375.0	.45	8.0	2.0
810120.1015	3.2	385.0	.32	9.1	2.3
810503.1230	3.8	382.0	3.80	1.40	9.4
810526.1200	-13.2	382.0	1.40	.55	8.3
810623.1635	16.0	354.0	3.00	7.9	1.9
810728.1105	22.0	364.0	1.10	7.8	2.0

DATE/TIME	KALAMALKA LAKE	OUTLET (50° 13' 54" N DP/TP SRP/TP SRP/DP PP PP/TP)	PHOSPHORUS		
			119	16/00	(W)
800908.1500	4 4 4 4 4	1 1 1 1 1	3 2 2 2 2	.3 .58 .58 .233 .3	.75 .75 .75 .75 .75
810120.1015	6 6 6 6 6	6 6 6 6 6	5 5 5 5 5		
810503.1230	9 9 9 9 9	9 9 9 9 9	2 2 2 2 2	.25 .25 .25 .25 .25	.64 .64 .64 .64 .64
810526.1200	0 0 0 0 0	0 0 0 0 0	0 0 0 0 0		
810623.1635	5 5 5 5 5	4 4 4 4 4	4 4 4 4 4	.42 .42 .42 .42 .42	.77 .77 .77 .77 .77
810728.1105	4 4 4 4 4	5 5 5 5 5	5 5 5 5 5	1.13 1.13 1.13 1.13 1	1.27 1.27 1.27 1.27 1

DATE/TIME	TN	TDN	PH	KALAMALKA LAKE OUTLET (50 13°54' N 119°06' W)				NITROGEN			PC
				NO ₃	NO ₂	N+H ₄	DIN	DON	NH ₄		
800908.1500	261	233	28	13	1	14	3	16	9	211	.339
									16	216	
810120.1015	246	215	31	55	3	58	6	64	64	161	.171
									4	57	.148
810503.1230	270	230	40	53	2	55	4	59	59	166	.160
									1	55	.156
810623.1635	227	195	41	3	3	5	3	59	59	155	.171
									1	55	.291
810728.1105	247	223	24	5	1	6	14	20	20	203	.236
									7	17	.209
									4	180	.211
									2	188	.206
									1	17	.223

		KALAMALKA LAKE OUTLET (50° 13' 54" N 119° 16' 00" W)	NITROGEN RATIOS					
DATE/TIME	TN/TN	PN/TN	NN/DIN	DIN/TN	DIN/DN	DON/TN	DON/DN	PC/PN
		.88	.13	.10	.10	.90	.12	
		.67	.33	.04	.04	.96		
		.84	.16	.06	.07	.93	.12	
800908.1500	.89	.11	.91	.09	.28	.72		
		.93	.07	.07	.28	.72		
		.98	.02	.02	.26	.74		
810120.1015	.87	.13	.94	.06	.24	.27	.64	.73
		.95	.05	.05	.23	.77		
		.95	.05	.05	.26	.74		
		.98	.02	.02	.26	.74		
810503.1230	.85	.15	.96	.04	.21	.25	.64	.75
		.10	.90	.04	.04	.96		
		.39	.70	.11	.11	.89		
		.18	.82	.16	.16	.84		
810526.1200	.85	.15	.21	.79	.09	.11	.76	.89
		.80	.20	.03	.03	.97		
		.62	.38	.06	.06	.94		
		.75	.25	.02	.02	.98		
810623.1635	.86	.14	.68	.32	.03	.04	.83	.96
		.30	.70			.95		
		.41	.59			.92		
		.43	.57			.94		
810728.1105	.90	.10	.37	.63	.07	.08	.83	.92

OKANOGAN LAKE OUTLET (49°36'06"N 119°36'45"W) GENERAL PHYS/CHEM
DATE/TIME Temp C C25 Turb NMLI Turb WOB S102 C1

800910,1230	17.0	268.0	.42	4.6	1.3
810122,1145	4.0	265.0	.28	4.8	1.7
810506,0930	9.0	264.0	1.90	1.20	4.6
810528,0900	14.9	266.0	1.80	.83	4.5
810626,0955	15.2	244.0	1.00	4.5	1.4
810730,1130	20.3	231.0	1.40	4.5	1.5

DATE/TIME	OKANOGAN LAKE TP	OUTLET DP	<49°30'06"N 119°36'45"W> PHOSPHORUS			PP/TP	
			SRP	SRP/TP	PP/DP		
800910, 1230	4	1	2	.50	1.00	2	.50
	4	0	2	2	.50		
	6	2	2	2			
	6	3	2	2	.33	.75	.56
810122, 1145	6	6	4	4	1		
	6	0	4	2	1		
	6	0	0	3	1		
	6	0	0	3	1		
	6	0	0	3	1		
810506, 0930	5	1	1	1	.12	.30	.50
	5	0	4	1	0		
	5	0	4	1	0		
	5	0	4	1	0		
810526, 0900	5	1	1	1	0		
	5	0	4	1	0		
	5	0	4	1	0		
	5	0	4	1	0		
810626, 0955	6	6	6	6	0		
	6	6	6	6	0		
	6	6	6	6	0		
	6	6	6	6	0		
810730, 1130	5	0	3	3	.45	1.50	.70
	5	0	3	3	.45	1.50	.70
	5	0	3	3	.45	1.50	.70

DATE/TIME	OKANOGAN LAKE	OUTLET	<49	30/06/86				36/45/86				NITROGEN				PR
				TN	TDN	PN	NO3	NO2	N+H	NH4	DIN	DIN	DON	DON	DIN	
800910.1230	226	205	21	21	4	1	5	3	3	1	3	217	217	217	.277	
				185		1	1	2	1	3	3	182	182	182		
				175	10	36	1	37	8	47	47	138	138	138		
				185		36	1	37	10	46	46	134	134	134	.140	
810122.1145	190	180	10	36	1	37	9	37	9	46	46	134	134	134	.140	
				180	37	5	2	7	10	17	17	163	163	163	.266	
				160	39	6	2	8	16	24	24	136	136	136	.314	
				145		3	1	4	5	5	5	136	136	136		
810506.0930	200	162	38	5	2	6	10	10	17	17	17	145	145	145	.290	
				185	27	1	1	2	2	3	13	15	170	170	170	.281
				185	28	1	1	1	1	2	2	8	11	174	174	.434
				145		1	1	1	1	2	2	4	4	141	141	
				153	22	2	2	2	2	2	8	10	162	162	162	.358
				160	23	2	0	2	2	2	2	4	4	145	145	.175
				152		1	1	2	2	3	5	7	7	145	145	.168
810626.0955	178	155	23	1								8	8	147	147	.172
				203	35	4	1	1	1	5	5	10	10	193	193	.274
				212	25	1	1	2	1	3	3	209	209	209	.212	
				195		5	1	6	9	5	5	180	180	180		
810730.1130	233	203	30	3								9	9	194	194	.243

OKANOGAN LAKE OUTLET (49°30'06''N 119°36'45''W)		NITROGEN RATIOS			
DATE/TIME	TDN/TN	PN/TN	NN/DIN	AN/DIN	DIN/TN
800910.1230	.91	.09	.64	.36	.02
					14
810122.1145	.95	.05	.86	.26	.24
					14
810506.0930	.81	.19	.38	.62	.08
					10
810528.0900	.86	.14	.23	.77	.05
					16
810626.0955	.87	.13	.43	.57	.04
					13
810730.1130	.87	.13	.46	.54	.04
					8

DATE/TIME	Temp C	C25	Turb NWR	Turb WOB	GENERAL PHYS/CHEM	
					C1	SiO2
800910.1320	18.0	260.0		.86	2.7	2.0
810122.1320	3.5	273.0		.32	3.8	2.3
810506.1045	9.5	274.0	1.40	.70	.2	2.3
810528.1040	14.8	266.0	2.80	1.60	1.4	2.0
810625.1540	17.0	236.0	1.40		3.0	1.6
810730.1335	21.1	244.0	1.80		4.2	1.7

DATE/TIME	SKAHA LAKE OUTLET (49°20'46''N 119°34'48''W)			PHOSPHORUS		
	TP	DP	DP/TP	SRP	SRP/TP	PP
800910, 1320	12	3		1		
	14	4		2		
	13	4	.27	2	.43	10
	27	18		15		.73
	26	18		15		
	27	18		16		
810122, 1320	27	18	.67	15	.57	
	27	18				
	12	5		1		
	12	4		2		
	12	5		1		
	12	5				
810506, 1045	12	5				
	11	1		1		
	11	1		1		
	11	1		2		
	11	1				
	11	1				
810528, 1040	11	1	.69	1		
	12	3		3		
	12	3		4		
	13	3		3		
	12	3		3		
	12	3				
810625, 1540	13	3				
	12	3				
	12	3				
	12	3				
	10	4		4		
	10	4		4		
810730, 1335	17	5				
	12	4				

APPENDIX I (Continued)

The following tables contain the data for water samples collected from stations within the Shingle and Vaseux Creeks drainage basins which were extensively sampled by OBIB. Our sampling only occurred on two dates, however: one in autumn, 1980 and one in spring, 1981.

No.	Location
Shingle Creek Drainage Basin	
1	Shingle Above Rogers Ranch
2	Shingle Below Rogers Ranch
3	Shatford @ Hydrometric Station
4	Shatford Above Fork @ Bridge
5	Shingle @ Lumber Mill
Vaseux Creek Drainage Basin	
6	MacIntyre
7	Upper Vaseux
8	Wabash
9	Vaseux @ Water Survey
10	Vaseux @ Highway 97
11	Under Down

DATE/TIME	SHINGLE CRK, WATERSHED SURVEY	GENERAL PHYS/CHEM
	LOC Temp C C25 Tb NRRI Tb WOB	SiO2 C1
801020.1030	1 6.0 285.0	.53 15.9 1:1
801020.1100	2 6.0 119.0	.47 16.6 1.6
801020.0930	3 6.0 168.0	.48 17.9 1.6
801020.1010	4 8.0 189.0	.54 13.8 2.2
801020.1245	5 10.0 184.0	.65 15.6 2.4

DATE/TIME	LOC	SHINGLE CRK.			WATERSHED SURVEY			PHOSPHORUS			PP	PP/TP
		TP	DP	DP/TP	SRP	SRP/TP	SRP/DP	PP	PP/TP	SRP/DP		
801020,1030	1	16	13		11			3				
		16	14		11			2				
		15	13		11			2				
	2	16	13	.85	11	.70	.83	2		.15		
		21	18		15			3				
		22	18		15			4				
801020,1100	1	22	18		14			4				
		22	18	.83	15	.68	.81	4		.17		
		12	8		7			4				
	2	12	8		7			4				
		15	8		7			7				
		15	8		7			5		.38		
801020,0930	3	13	6		.62			3				
		7	4		2			3				
		10	6		3			4				
	4	7	4		2			3				
		8	5		.58			3		.42		
		15	11		9			4				
801020,1010	5	15	11		11			4				
		15	11		11			4				
		15	11		9			4				
801020,1245	5	15	11		.73			4		.27		
		15	11		10			4		.88		

DATE/TIME	LOC	TN	TDN	SHINGLE CRK.			WATERSHED			SURVEY			NITROGEN			PC
				PN	NO3	NO2	N+H	NH4	DIN	DON	PC	PC	PC	PC	PC	
801020,1030	1	186	170	14	0	0	1	1	1	2	168	169				
			170	14	0	0	1	1	1	2	168	168				
			170	18	0	0	1	1	1	2	168	202				
			170	16	0	0	1	1	1	2	168	181				
			170	16	0	0	1	1	1	2	168	184				
801020,1100	2	397	390	14	182	2	184	18	202	188	193					
			388	27	177	3	180	3	183	197	258					
			360	21	175	4	179	1	180	180	255					
			377	21	178	3	181	8	189	188	235					
801020,0930	3	242	215	28	51	3	54	12	66	149	263					
			215	22	49	2	51	15	66	149	223					
			220	26	49	2	51	17	68	152	257					
			217	25	59	2	52	15	67	150	248					
801020,1010	4	261	170	37	18	2	20	3	23	147	318					
			285	32	18	2	20	40	60	225	296					
			210	49	17	2	19	12	31	179	358					
			222	39	18	2	20	18	38	184	324					
801020,1245	5	201	195	14	0	1	1	1	2	193	191					
			185	10	0	1	1	1	2	183	170					
			180	19	0	1	1	1	2	178	209					
			187	14	0	1	1	1	2	185	190					

DATE/TIME	SHINGLE CREEK WATERSHED SURVEY			NITROGEN RATIOS				
	TIN/TN	TIN/TH	PN/TH	NN/DIN	AN/DIN	DIN/TN	DON/TN	PC/DN
801020, 1030	.91	.09		.50	.50	.01		.99 12
				.50	.50	.01		.99 11
				.50	.50	.01		.99 11
				.50	.50	.01		.99 12
801020, 1100	.95	.05		.91	.09	.52		.48 14
				.98	.02	.48		.52 10
				.99	.01	.50		.50 12
				.96	.04	.47		.50 11
801020, 0930	.90	.10		.82	.18	.31		.69 9
				.77	.23	.31		.69 10
				.75	.25	.31		.69 10
				.78	.22	.31		.69 10
801020, 1010	.85	.15		.87	.13	.14		.66 9
				.33	.67	.21		.79 9
				.61	.39	.15		.85 7
				.52	.48	.17		.83 8
801020, 1245	.93	.07		.50	.50	.01		.99 14
				.50	.50	.01		.99 17
				.50	.50	.01		.99 11
				.50	.50	.01		.99 13

DATE/TIME	LOC	SHINGLE CRK. WATERSHED SURVEY		GENERAL PHYS/CHEM		SiO ₂	C1
		C25	Turb	NWRI	Turb		
810430,1515	1	11.0	209.0	2.10	18.5	1.3	
810430,1430	2	9.5	120.0	24.00	16.8	1.6	
810430,1700	3	11.0	152.0	30.00	13.00	18.1	1.7
810430,1350	4	14.5	211.0	25.00	12.00	17.7	2.1
810430,1700	5	16.5	232.0	20.00	9.00	16.8	2.5

DATE/TIME	LOC	SHINGLE CRK. WATERSHED SURVEY	PHOSPHORUS			PP/TP
			TP	DP/TP	SRP/TP	
810430.1515	1	54	.36	.33		.18
		51	.36	.33		.15
		55	.36	.33		.19
		53	.36	.33	.92	.17
		55	.68			13.33
810430.1430	2	138	.49	.27		.98
		162	.37	.27		.125
		148	.36	.27		.112
		149	.38	.25	.18	.72
		161	.39	.28		.161
810430.1700	3	191				
		136	.39	.27		.106
		157	.31	.27		.126
		161	.30	.19	.17	.90
		161				77.06
810430.1350	4	108	.24	.20		.84
		108	.24	.20		.84
		103	.24	.20		.79
		106	.24	.23	.19	.83
		106				39.21
810430.1700	5	84	.21	.14		.63
		90	.20			.70
		84	.17	.14		.67
		86	.19	.22	.16	.72
		86				26.67

DATE/TIME	LOC	SHINGLE CRK.			WATERSHED			SURVEY NITROGEN			DON	PC	
		TN	TDN	PN	NO3	NO2	N+N	NH4	DIN				
810430,1515	1	295	58	14	2	16	2	18	277	.933			
		286	64	15	3	18	2	20	260	.876			
		300		1	1	2	2	4	296				
		292	61	10	2	12	2	14	278	.905			
810430,1430	2	570	238	195	5	200	4	204	366	3.659			
		580	237	195	5	200	5	205	375	3.436			
		600		196	4	200	3	203	397				
		583	238	195	5	200	4	204	379	3.648			
810430,1700	3	249	225	42	4	46	1	47	193	3.298			
		235	236	47	4	51	1	52	183	3.295			
		240		43	5	48	1	49	191				
		238	231	44	4	48	1	49	189	3.297			
810430,1350	4	320	221	56	4	60	10	70	250	3.154			
		300	205	60	3	63	8	71	229	2.652			
		299			2		2						
		303	213	59	3	62	7	68	235	2.903			
810430,1700	5	516											
		295	168	6	2	8	1	9	236	1.788			
		280	180	2	3	5	1	6	274	2.068			
		260		4	2	6	1	7	253				
810430,1700	5	452	278	174	4	2	6	1	7	271	1.928		

DATE/TIME	SHINGLE CRK. WATERSHED SURVEY	NITROGEN RATIOS					
		TDN/TH	PN/TH	NN/DIN	DIN/TH	DIN/DN	PC/PN
810430, 1515	.83	.17	.86	.14	.04	.05	.79
810430, 1430	.71	.29	.98	.02	.25	.35	.46
810430, 1700	.51	.49	.98	.02	.11	.21	.40
810430, 1350	.59	.41	.90	.10	.13	.22	.46
810430, 1700	.62	.38					

DATE/TIME	LOC	VASEAUX CRK. WATERSHED SURVEY			GENERAL PHYS/CHEM		
		Temp C	C25	Tb	NWRI Tb	WQB	SiO2
800911.1125	6	6.0	41.0		.52	13.9	.3
800911.1145	7	7.0	73.8		.74	15.1	.5
800911.1310	8	6.0	45.5		.43	15.2	.3
800911.1400	9	7.5	73.8		.36	15.2	.3
800911.0000	10	21.0	177.0		.47	13.1	2.1

DATE/TIME	LOC	VASEAUX CRK.			WATERSHED SURVEY			PHOSPHORUS		PP	PP/TP
		TP	DP	DP/TP	SRP	SRP/TP	SRP/DP	PP	PP/DP		
800911.1125	6	.5	.3	.2	.63	.1	.25	.40	.2	1	.38
800911.1145	7	.0	.0	.0	.73	.2	.27	.36	.2	2	.27
800911.1310	8	.5	.4	.9	.56	.1	.22	.40	.2	1	.44
800911.1400	9	.6	.7	.5	.69	.4	.4	.62	.2	2	.31
800911.0000	10	.5	.4	.2	.44	.3	.3	.67	1.50	3	.56

DATE/TIME	LOC	WATERAUX	CRK.	WATERSHED SURVEY			NITROGEN			DON	PC
				TN	TDN	PN	N03	N02	N+N	NH4	DIN
800911.1125	6	191	175	3	28	1	29	25	54	121	.118
			200		14	1	15	13	28	172	
			188	3	21	1	22	19	41	147	.118
800911.1145	7	216	230	11	3	1	4	4	16	212	.154
			180		6	1	7	1	18	162	
			205	11	5	1	6	13	18	187	.154
800911.1310	8	156	145	3	11	1	12	4	16	129	.123
			160		17	1	18	1	19	141	
			153	3	14	1	15	3	18	135	.123
800911.1400	9	153	130	3	7	1	8	1	9	121	.125
			179		9	1	10	1	11	159	
			150	3	8	1	9	1	10	140	.125
800911.0000	10	295	255	25	3	1	4	36	34	221	.218
			285		3	1	4	16	20	265	
			270	25	3	1	4	23	27	243	.216

DATE/TIME	VASEUX CRK.	WATERSHED SURVEY	NITROGEN RATIOS
10/10/01 10:00 AM	EN/CDIN	EN/CDIN	EN/CDIN/TH
10/10/01 10:00 AM	PC/PH	PC/PH	PC/PH

DATE/TIME	LOC	Temp C	C25	Turb	NWRI	Turb	WQB	SiO2	C1
810501.1110	7	0.0	44.0	15.00		7.20		13.3	.8
810501.1210	8	0.0	46.8	2.80		2.50		17.4	1.2
810505.1330	11	1.5	33.2		1.40		1.50	15.7	.7
810505.1300	9	2.0	40.1		3.50		1.30	14.6	1.2
810501.1655	10	6.8	45.0	24.00		7.50		13.6	.9

DATE/TIME	LOC	VASEUX CRK.			WATERSHED SURVEY			PHOSPHORUS			PP	PP/TP
		TP	DP	DP/TP	TP	SRP	SRP/TP	SRP/DP	TP	TP		
		52	15		4						.37	
		53	15		4						.38	
		52	16		4						.36	
		52	15	.29	4	.08		.26			.37	.71
810501.1110	7	29	18			60	0				11	
		25	18			60	0				7	
		24	20			60	0				4	
810501.1210	8	26	19	.72	2	.69		.13			7	.28
		15	11			6					4	
		13	16			6					3	
		13	16			1					3	
810505.1330	11	14	10	.76	2	.15		.19			3	.24
		21	11			4					10	
		26	11			4					9	
		19	11			4					8	
810505.1300	9	26	11	.55	4	.26		.36			9	.45
		88	19			6					69	
		87	20			7					67	
		88	20			7					68	
810501.1655	10	68	20	.22	7	.08		.37			68	.78

DATE/TIME	LOC	VASEAUX CRK. WATERSHED SURVEY						NITROGEN			PC
		TN	TDN	PN	N03	N02	NH4	DIN	DON		
810501.1110	7	320	89	1	3	12	16	304	1.275		
		305	54	2	2	12	16	289	.747		
		325		1	3	11	15	310			
		317	72	2	2	8	12	304	1.011		
810501.1210	8	485	26	3	3	52	58	427	.291		
		460	25	5	2	25	32	428	.296		
		510		6	4	97	107	403			
		485	25	5	3	58	66	419	.294		
810505.1330	11	230	17	1	3	4	8	222	.168		
		275		22	3	11	36	239			
		235	18	1	3	16	20	215	.195		
		247	16	8	3	10	21	225	.182		
810505.1300	9	225	16	2	4	3	9	216	.194		
		235	15	3	3	7	13	222	.188		
		210		2	3	4	9	201			
		223	16	2	3	5	10	213	.191		
810501.1655	10	290	65	7	2	11	20	270	.1.164		
		300	74	2	3	9	14	286	.1.108		
		300		5	1	6	12	288			
		297	69	5	2	9	15	261	1.136		

DATE/TIME	VASEUX CRK. WATERSHED SURVEY NITROGEN RATIOS							
	TDN/TH	PN/TH	NH/DIN	AN/DIN	DIN/TH	DON/TH	DON/IN	PC/IN
810501.1116	.81	.19	.25	.75	.05	.95	.14	.95
			.25	.75	.05	.95	.14	.95
			.27	.73	.05	.95	.14	.95
			.32	.68	.03	.94	.14	.96
			.16	.98	.12	.88	.11	.93
			.22	.78	.07	.93	.12	.93
			.09	.91	.21	.79	.12	.86
			.12	.88	.13	.14	.02	.86
			.58	.58	.03	.97	.10	.97
			.69	.31	.13	.87	.11	.91
			.26	.86	.09	.91	.10	.91
			.52	.48	.08	.65	.04	.96
			.67	.33	.04	.94	.12	.94
			.46	.54	.06	.96	.13	.94
			.56	.44	.04	.96	.12	.95
			.55	.45	.04	.89	.05	.77
				1.40				
				.45	.55	.07	.93	.18
				.36	.64	.05	.95	.15
				.59	.59	.04	.96	.16
				.43	.57	.04	.77	.95
810501.1655	.81	.19						

APPENDIX II

BAP and BAN Contents

Based on the 10 Year Average Discharge

Deep	n	10^6m^3	Average	Phosphorus		Average		Nitrogen		
			Discharge	Concentration	Loading	Concentration	Loading	kg•yr ⁻¹	kg•yr ⁻¹	
				$\mu\text{g}\cdot\text{L}^{-1}$	$\mu\text{g}\cdot\text{L}^{-1}$	$\mu\text{g}\cdot\text{L}^{-1}$	$\mu\text{g}\cdot\text{L}^{-1}$	TN	BAN	
				TP	BAP	TP	BAP	TN	BAN	
low discharge period	4	5.7	394	389	2246	2217	1527	1147	8704	6538
high discharge period	3	9.8	289	273	2832	2675	1258	964	12328	9447
annual	7	15.5			5080	4890			21000	16000
		%				100	96		100	76

Comments:

1. Hydrometric station 08NM153;
2. Discharge data: 1970-74 (4 years);
3. High discharge period: March, April, May, June;
4. High discharge sampling dates: 81/04/03, 05/26, 06/23; based on upstream station 08NM19.

Ej uesis	n	10 ⁶ m ³	Discharge	Concentration µg·L ⁻¹	Phosphorus	Average Concentration µg·L ⁻¹	Nitrogen Loading kg·yr ⁻¹	Nitrogen Loading kg·yr ⁻¹	
					TP	BAP		TP	BAP
low discharge period	4	6.14	33	28	203	172	386	322	2370
high discharge period	2	14.7	100	53	1466	777	401	292	5879
annual	6	20.8			1670	950			8250
		%			100	57			6260
								100	76

Comments:

1. Hydrometric station 08NM161;
2. Discharge data: 1970-72 and 1977-79 (5 years complete);
3. High discharge period: April, May, June;
4. High discharge sampling dates: 81/05/03, 05/26.

Coldstream	n	10^6m^3	Discharge	Average Concentration		TP	BAP	Phosphorus Loading $\text{kg} \cdot \text{yr}^{-1}$	Concentration $\mu\text{g} \cdot \text{L}^{-1}$	BAN	TN	Nitrogen Loading $\text{kg} \cdot \text{yr}^{-1}$	BAN
				TP	BAP								
low discharge period	5	6.8	69	43	469	292	1929	1827	13115	12422			
high discharge period	3	11.9	117	45	1392	536	753	634	8961	7545			
annual	8	18.7			1860	830			22100	20000			
		%				100	44		100	90			

Comments:

1. Hydrometric station 08NM179 was slightly upstream of the sampling station;
2. Discharge data: 1970-75, 1977-79 (9 years);
3. High discharge period: April, May, June;
4. High discharge sampling dates: 81/05/03, 05/26, 06/23;
5. There were only 4 samples for the nitrogen components in the low discharge period.

Vernon above Hiram Walker	n	10^6m^3	Average Discharge	Concentration $\mu\text{g}\cdot\text{L}^{-1}$	Phosphorus Loading $\text{kg}\cdot\text{yr}^{-1}$	Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$	Nitrogen Loading $\text{kg}\cdot\text{yr}^{-1}$
			TP	BAP	TP	TN	BAN
low discharge period	5	2.01	26	23	54	47	414
high discharge period	3	10.1	48	37	485	369	386
annual	8	12.1			540	415	224
%					100	77	3899
						100	832
						59	513

Comments:

1. Hydrometric station 08NM162 was downstream of the sampling station and below the Hiram-Walker cooling water discharge;
2. Discharge data: only 1972-74; data at this station was compared to the 1972-74 data set on Vernon Creek at Wood Lake and then the 10 year average was proportionally calculated using the 10 year data set 1970-79 on the latter station; average monthly cooling water discharge was subtracted from the synthetic hydrograph;
3. High discharge period: April, May, June;
4. High discharge sampling dates: 81/05/04, 05/27, 06/24;
5. There were only 4 samples for the nitrogen components in the low discharge period.

Vernon below Hiram Walker	n	Discharge 10^6 m^3	Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$	Phosphorus Loading $\text{kg}\cdot\text{yr}^{-1}$	Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$	Nitrogen Loading $\text{kg}\cdot\text{yr}^{-1}$
		TP	BAP	TP	BAP	TN
low discharge period	3	4.45	20	16.5	89	73
high discharge period	2	10.9	39.5	28	431	305
annual	5	15.4			520	378
%					100	73
						100
						58

Comments:

1. Hydrometric station 08NM162;
2. Discharge data: only 1972-74; data at this station was compared to the 1972-74 data set on Vernon Creek at Wood Lake (08NM009) and then proportionality for those 3 years was applied to the 10 year data set at the latter station;
3. High discharge period: April, May, June;
4. High discharge sampling dates: 81/05/27, 06/24;
5. BAP content of PP was assumed to be the same as Vernon Creek above Hiram Walker.

Winfield	n	10^6m^3	Average Concentration			TP	BAP	TN	BAN	TP	BAP	$\mu\text{g}\cdot\text{L}^{-1}$	$\text{kg}\cdot\text{yr}^{-1}$	Average Concentration	$\mu\text{g}\cdot\text{L}^{-1}$	$\text{kg}\cdot\text{yr}^{-1}$	Nitrogen Loading	Nitrogen Loading
			Discharge	$\mu\text{g}\cdot\text{L}^{-1}$	kg $\cdot\text{yr}^{-1}$													
low discharge period																		
high discharge period																		
annual	7		2.15	41	40	88	86	2,493	2,444	5,360	5,255							
		%																

Comments:

1. Hydrometric station 08NWL81 was slightly upstream of the sampling station;
2. Discharge date: (1971-1973) only 1972 was complete;
3. The discharge was essentially constant because the source is a spring;
4. There were only 6 samples for the nitrogen components.

Mission	n	10^6 m^3	Average	Phosphorus	Average	Nitrogen		
			Discharge	Concentration $\mu\text{g}\cdot\text{L}^{-1}$	Loading $\text{kg}\cdot\text{yr}^{-1}$	Concentration $\mu\text{g}\cdot\text{L}^{-1}$	Loading $\text{kg}\cdot\text{yr}^{-1}$	
			TP	BAP	TP	BAP	TN	BAN
low discharge period	5	49.4	15	10	741	494	312	228
high discharge period	2	139	143	57	19877	7923	341	244
annual	7	188			20600	8420		
					100	41	62800	45200
							100	72

Comments:

1. Hydrometric station 08NM116 is 6 km upstream of the sampling site;
2. Discharge data: 1970-79 (10 years);
3. High discharge period: April, May, June;
4. High discharge sampling dates: 81/05/02, 05/27.

Lambly	n	10^6m^3	Discharge	Average Concentration		TP	BAP	Phosphorus Loading $\text{kg} \cdot \text{yr}^{-1}$	Concentration $\mu\text{g} \cdot \text{L}^{-1}$	TN	BAN	Nitrogen Loading $\text{kg} \cdot \text{yr}^{-1}$	TN	BAN
				TP	BAP									
low discharge period	4	8.74	12.5	11.5	109	101	193	116	1687	1014				
high discharge period	2	38.25	55	35	2104	1339	364	226	13923	8645				
annual	6	47			2210	1440			15600	9660				
		%			100	65			100	62				

Comments:

1. Hydrometric station 08NM166 is 7 km upstream and above an irrigation diversion. A comparison of this hydrometric station with the 1971-74 data set at the month (08NM003) showed the difference was only 2%;
2. Discharge data: 1971-79 (9 years);
3. High discharge period: April, May, June;
4. High discharge sampling dates: 81/05/02, 05/27.

Trout	n	10^6 m^3	Average		Phosphorus		Average		Nitrogen	
			Discharge	Concentration	Loading	Concentration	Loading	BAP	TN	BAN
			$\mu\text{g}\cdot\text{L}^{-1}$	$\mu\text{g}\cdot\text{yr}^{-1}$	TP	BAP	TP	BAP	TN	BAN
low discharge period	3	11.3	31	8	354	87	1336	1016	15093	11477
high discharge period	3	52.3	121	19	6311	1008	328	207	17154	10826
annual	6	63.6			6665	1095			32200	22300
		%			100	16			100	69

Comments:

1. Hydrometric station 08NM158;
2. Discharge data: 1970-79 (10 years);
3. High discharge period: May, June, July;
4. High discharge sampling dates: 81/04/30, 05/28, 06/26.

Shingle	n	10^6m^3	Average		Phosphorus		Average		Nitrogen	
			Discharge	Concentration $\mu\text{g}\cdot\text{L}^{-1}$	TP	BAP	TP	BAP	TN	BAN
low discharge period	4	2.47	29	22	72	54	273	171	674	422
high discharge period	2	9.63	261	141	2509	1358	480	349	4622	3361
annual	6	12.1			2580	1410			5300	3780
		%					100	55	100	71

Comments:

1. Hydrometric station 08NM150;
2. Discharge data: 1970-72 and 1977-79 (4 years complete);
3. High discharge period: May, June;
4. High discharge sampling dates: 81/04/30, 05/28.

Vaseux	n	10 ⁶ m ³	Discharge	Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$	Phosphorus Loading $\text{kg}\cdot\text{yr}^{-1}$	Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$	Nitrogen Loading $\text{kg}\cdot\text{yr}^{-1}$
low discharge period	4	10.1	8	6	81	63	223
high discharge period	2	33.1	56	26	1854	867	307
annual	6	43.2			1935	930	

Comments:

1. Hydrometric station 08NM015 is over 3 km upstream and above a significant tributary addition. During low discharge periods, losses to ground water between the hydrometric station and the Okanagan river as well as evaporative losses are liable to be a large but unknown percentage of the discharge. Whether the additional flow provided by Dutton Creek is compensated by these other losses is unknown;
 2. Discharge data: 1970-79 (10 years);
 3. High discharge period: May, June;
 4. High discharge sampling dates: 81/05/01; 05/28.

Vernon above Wood Lake	n	10^6 m^3	Discharge period	Average Concentration		TP	BAP	Phosphorus Loading $\mu\text{g L}^{-1}$ kg yr^{-1}	Concentration $\mu\text{g L}^{-1}$ BAN	TN	BAN	Nitrogen Loading kg yr^{-1} BAN
				TP	BAP							
low discharge	6	4.6	64	47	295	215	1246	1060	5733	4874		
high discharge	3	8.1	137	78	1110	632	721	570	5840	4617		
annual	9	12.7			1405	850			11600	9490		
		%			100	60			100	82		

Comments:

1. Hydrometric station 08NM009 is slightly upstream of the sampling station;
2. Discharge data: 1970-79 (10 years);
3. High discharge period: April, May, June;
4. High discharge sampling dates: 81/05/04, 05/27, 06/24.
5. There were only 5 nitrogen samples in the low discharge period.

Vernon above Okanagan L.	Discharge 10^6m^3	Average Concentration			Phosphorus			Average Concentration			Nitrogen Loading		
		TP	BAP	TP	BAP	TN	BAN	TN	BAN	kg yr ⁻¹	kg yr ⁻¹	TN	BAN
low discharge period	4	27.7	43	36	1191	987	736	615	20378	17026			
high discharge period	4	18.3	54	34	988	620	445	315	8148	5760			
annual	8	46.0			2180	1610			28500	22800			
		%				100	74		100	80			

Comments:

1. Hydrometric station 08NNM160 is 2 km upstream of the sampling station;
2. Discharge data: 1970-79 (10 years);
3. High discharge period: May, June;
4. High discharge sample dates: 81/05/03, 05/26, 06/23, 07/27;
5. There were only 3 samples for nitrogen components in the low discharge period.

Skaha L. Inlet	n	10^6 m^3	Discharge	Concentration $\mu\text{g} \cdot \text{L}^{-1}$	Average		Phosphorus Loading $\text{kg} \cdot \text{yr}^{-1}$	Concentration $\mu\text{g} \cdot \text{L}^{-1}$	Average		Nitrogen Loading $\text{kg} \cdot \text{yr}^{-1}$
					TP	BAP			TN	BAN	
low discharge period	3	285		24	19		6,840	5,420	467		350
high discharge period	3	240		99	34		23,800	8,160	332		248
annual	6	525					30,600	13,600			213,000
		%							100	44	159,000
										100	75

Comments:

1. Hydrometric data included Okanagan Lake outlet (08NM050), Ellis Creek (08NM035) and Shingle Creek (08NM150);
2. Discharge data: 1970-1979 for lake outlet; 1970, 71, 73, 74, 78, 79 for Ellis; and 1970, 71, 78, 79 for Shingle;
3. High Discharge period: April, May, June, July;
4. High discharge sampling dates: 81/05/28, 06/26, 07/30;
5. Unusually high discharge from Shingle and Ellis Creeks during a rainstorm event 05/25 caused very high PP concentration which increased the high discharge average TP ;and BAP considerably;
- 6.. BAP content of PP assumed to be 90% on 09/10, 01/22; 50% on 05/06, 06/26, 07/30; and 30% on 05/28.

Osoyoos L. Inlet	Discharge 10^6 m^3	Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$		Phosphorus Loading $\text{kg}\cdot\text{yr}^{-1}$		Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$		Nitrogen Loading $\text{kg}\cdot\text{yr}^{-1}$	
		n	TP	BAP	TP	BAP	TN	BAN	TN
low discharge period	3	310	45	24	14,000	7,440	432	313	134,000
high discharge period	3	258	26	17	6,700	4,390	283	184	73,000
annual	6	568			20,700	11,800			207,000
		%					100	57	144,000
							100	70	

Comments:

1. Hydrometric station 08NM085 was 5 km upstream of the sampling station.
2. Discharge data: 1970-79 (10 years);
3. High discharge period: April, May, June and July;
4. High discharge sampling dates: 81/05/28, 06/25, 07/30;
5. Unusually low discharge from Skaha Lake on 81/05/01 resulted in very high TP concentrations which have increased the low discharge average considerably;
6. BAP content of PP was assumed to be 30% except for 80/09/11 and 81/01/22 when it assumed to be 50%.

Ellison L. Outlet	n	Discharge 10^6m^3	Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$			Phosphorus Loading $\text{kg}\cdot\text{yr}^{-1}$			Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$			Nitrogen Loading $\text{kg}\cdot\text{yr}^{-1}$	
			TP	BAP	TP	BAP	TN	BAN	TN	BAN	TN	BAN	
winter period	1	2.2	26	24.5	57	54	380	246	836	541			
spring, summer fall period	5	10.5	83	77	872	809	899	689	9440	7235			
annual	6	12.7			930	865			10,300	7780			
		%			100	92			100	76			

Comments:

1. Hydrometric station 08NM182 was only operational for 1972, 73 and 74; the average 10 year hydrology was assumed to be close to the station downstream at Wood Lake (08NM009);
2. Winter period: December - March;
3. BAP content of PP assumed to be 90%;
4. Very low discharge and complete mixing of Ellison L. lead to very high concentrations of N and P on 80/09/09, which has increased the non-winter average considerably.

Wood L. Outlet	Discharge 10^6m^3	Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$			Phosphorus Loading $\text{kg}\cdot\text{yr}^{-1}$			Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$			Nitrogen Loading $\text{kg}\cdot\text{yr}^{-1}$	
		n	TP	BAP	TP	BAP	TN	BAN	TN	BAN		
winter	1	2	74	73.5	148	147	497	348	994	696		
spring, summer fall period	7	6.2	27	26	167	161	455	273	2821	1693		
annual	8	8.2			315	308			3815	2390		
		%					100	98		100	63	

Comments:

1. Hydrology synthesized from Vernon Creek at inlet (08NM009) and estimated evaporation occurring during summer equivalent to 483 mm;
2. Discharge data: 1970-79 (10 years);
3. Winter period: December - March;
4. BAP content of PP assumed to be 90%.

Kalamalka L. Outlet	Discharge n 10 ⁶ m ³	Average Concentration µg·L ⁻¹		Phosphorus Loading kg·yr ⁻¹		Average Concentration µg·L ⁻¹		Nitrogen Loading kg·yr ⁻¹	
		TP	BAP	TP	BAP	TN	BAN	TN	BAN
winter period	2	7.4		7.5	7	55.5	51.8	176	1910
spring, summer fall period	4	21		6.3	5.9	132	124	253	5310
annual	6	28.4	%			188	176	7220	4450
						100	94	100	62

Comments:

1. Hydrometric station 08NM065;
2. Discharge data: 1970-79 (10 years); September - December 1973 data was synthesized from downstream station at Okanagan Lake 08NM160;
3. Winter period: December - April;
4. BAP content of PP assumed to be 90%.

Okanagan L. Outlet	Discharge n	10 ⁶ m ³	Average Concentration TP µg·L ⁻¹	Average Concentration BAP µg·L ⁻¹	Phosphorus Loading kg·yr ⁻¹	Concentration TN µg·L ⁻¹	Concentration BAN µg·L ⁻¹	Nitrogen Loading kg·yr ⁻¹	
								TN	BAN
winter	1	248	6	5.5	1,490	1,360	190	123	47,100 30,500
spring, summer	5	251	6	5.0	1,510	1,255	207	123	51,950 30,900
fall									
annual	6	499			3,000	2,620		99,100	61,400
		%					100	87	100 62

Comments:

1. Hydrometric station 08NM050;
2. Discharge data: 1970-79 (10 years);
3. Winter period: December - March;
4. BAP content of PP assumed to be 90%.

Skaha L. Outlet	Discharge n	10 ⁶ m ³	Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$	Phosphorus		Average Concentration $\mu\text{g}\cdot\text{L}^{-1}$	Nitrogen	
				TP	BAP		TP	BAN
winter period	1	142	27	26	3830	3690	397	283
spring, summer fall period	5	394	12	11	4730	4335	278	178
annual	6	536			8560	8030		166,000
		%			100	94		110,000
							100	66

Comments:

1. Hydrometric station 08NM002;
2. Discharge data 1970-79 (10 years);
3. Winter period: December - March;
4. BAP content of PP assumed to be 90%.

APPENDIX III

Areal Yield Estimates for "Natural" Runoff

To estimate areal nutrient yields from natural runoff, the annual nutrient export from undisturbed tributaries were divided by the drainage basin areas. Although there are no tributaries completely free of cultural activity, there were 4 considered to be unaffected except for logging activities and small reservoir construction. The four tributaries chosen were upper Vernon, Mission, Lambly and Vaseux Creeks. The hydrologic record for each station was not very satisfactory with no sampling site being coincident with hydrometric station. The amount of logging was also a problem in that the area logged in the last 10 years varied considerably.

The annual area yields varied between 4.3 and $23 \text{ kg} \cdot \text{km}^{-2}$ for phosphorus and between 37 and $72 \text{ kg} \cdot \text{km}^{-2}$ for nitrogen (Table 11).

These yields must be treated as extremely preliminary and probably underestimates due to the low number of sampling dates and the lack of samples during rain storm events and peak flows during snow melt. Compared to yields in other areas of North America, these Okanagan tributaries are very low for both P and N. TP yields

elsewhere are generally above $20 \text{ kg} \cdot \text{km}^{-2} \cdot \text{yr}^{-1}$ except for forested areas on the Canadian Shield (Dillon and Kirchner, 1975).

In an extensive review of the literature Reckhow (1980) found no TN yields below $130 \text{ kg} \cdot \text{km}^{-2} \cdot \text{yr}^{-1}$ for forested drainage basins.

In contrast the highest value obtained here was 72 $\text{kg} \cdot \text{km}^{-2} \cdot \text{yr}^{-1}$. The extremely low nitrogen yields result in a BAN/BAP ratio in the export of 6.4 which would lead to nitrogen limited lakes in the natural precultural situation.

"Natural" annual nutrient yields.

Tributary	Area km^{-2}	Areal Yield $\text{kg} \cdot \text{km}^{-2}$		Areal yield $\text{kg} \cdot \text{km}^{-2}$	
		TP	TN	BAP	BAN
Upper Vernon	127	4.3	37	3.3	22
Mission	873	23	72	9.6	52
Lambly	272	8	57	5.3	36
Vaseux	255	7.5	49	3.7	29
Average		10.7	54	5.5	35