Reprint 227

ESTIMATES OF NITGROGEN AND PHOSPHOROUS LOADINGS

TO THE CHAIN-LINK-OSPREY LAKES SYSTEMS

FROM

DOMESTIC WASTE SOURSES

by

L.E.H. Lacelle
Pedologist
Ministry of Environment and Parks
Wildlife Program
Okanagan Sub-Region

December 1986

TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF MAPS

1.0 INTRODUCTION

Chain, Link and Osprey Lakes occupy depressions on the floor of a major glacially sculptured through valley that contains both Hayes Creek running west from Osprey Lake and Trout Creek running east from the eastern end of the study area, immediately east of Osprey Lake. The lakes are described in Water Investigations publications (1977,1977,1978) as becoming eutrophic. The Habitat Management Section and the Fisheries Branch of the Ministry of Environment are concerned that in view of the predominance of coarse textured soils and with the proliferation of cottages and residences around the lakes, that lake eutrophication will become an increasingly severe problem, particularly with reference to fish kills. This report addresses this concern and at the same time provides technical data on waste loading to land and surface waters to aid Regional District of Okanagan South planning staff in preparation of an effective Rural Land use bylaw for the area.

The study focuses on four main criteria:

1. the constraints limiting the use of septic tank waste disposal systems in the area,
2. the suitability of the study area for this method of waste disposal,
3. the estimated quantities of nitrogen and phosphorous loading delivered to the waterbodies at present, and
4. given current zoning, the estimated potential nitrogen and phosphorous loadings should the area become fully developed.

Improved and alternative methods of waste disposal suitable for use in the study area are also briefly discussed.

2.0 METHODOLOGY

2.1 General

Available technical literature on the nutrient status of the lakes (Water Investigations Branch 1977, 1977, 1978, Murphy and Urciuoli, unpubl.), constraints limiting use of septic tank systems in such environments (Epp, 1984), soils reports (Lord and Greene, 1974) and nutrient loading studies in similar environments (Canadian Bio. Resources Engineering Ltd., 1982, Epp, 1983, Wiens, 1983), was reviewed. Pertinent technical data was extracted and methodologies for field survey, data analysis and data reporting were determined. Land units likely to have similar constraints limiting use of septic tank systems were mapped on aerial photographs.

2.2 Field Survey

Three days of field survey were carried out to collect pertinent data including soil texture, permeability (percolation rate), drainage, depths to impermeable bedrock or water table, landform, topography and slope. Areas suspected of being subject to flooding or high water tables were field checked to refine map unit boundaries and to determine water table heights. Interviews were utilized to obtain pertinent on-site data. Two percolation tests were carried out on typical soils.

2.3 Soil Constraints and Soil Suitability for Septic Tank Waste Disposal Systems

A soil constraints for septic tank waste disposal map was prepared by applying the soil constraint classes (1 to 4 - slight to very severe constraints) described in the Ministry of Environment Soil Constraints for Septic Tank Effluent Absorption manual (Epp, 1984) to the map units. The same units were then rated for suitability for septic tank waste disposal systems using a methodology currently being developed for the Waste Management Branch (Wiens, unpubl.).

2.4 Estimates of Present Nitrogen and Phosphorous Loadings to Surface Waters

The locations of all permanent residences, seasonal residences and recreation site campsites were determined from study of aerial photography and were plotted on a 1:6000 scale planimetric map. The number of permanent residences was estimated by analysis of assessment rolls and by field observation. All dwellings/camp-sites were categorized into three distance classes from surface waters (including lakes, streams and intermittently flooded streams and wetlands). The distance classes are < 60 m (< 200'), 60-120 m and > 120 m. The zone < 60 m back from surface waters was utilized as it is an area where wastewater discharges from septic fields, pit toilets or greywater sumps are likely to at least partially enter the surface waters. The 60-120 m zone was utilized as representing a zone where soil retention of effluent nutrients and pathogens would be significant, but where contributions to surface waters would still be expected. Dwellings > 120 m distant were considered to be negligible contributors. A four year average number of camper days per season for the three recreation sites was calculated from Ministry of Forests data. The number of residences and camper days were also categorized as to the type of soil the dwellings/campsites occur upon.

In order to estimate the number of contributors of waste water effluent, each residence was assumed to be occupied by three people. To be able to compare quantities of waste discharge from permanent residences, seasonal residences and campgrounds, the latter two were assumed to be occupied for only 2 1/2 months of the year. Consequently, their population estimates (Population Equivalent Values) were reduced by a factor of $\frac{2.5}{12}$ in order that nitrogen and phosphorous soil loading and surface water contribution values would be on a comparable annual basis.

Estimates of nitrogen and phosphorous loadings to the soil from septic fields, pit toilets and greywater sumps were determined from pertinent literature (Environmental Protection Agency, 1977, 1980). All permanent residences were considered to have septic systems receiving waste contributions from toilets, kitchen sink, bathroom sink and bath, automatic dishwater and washing machine. Due to a lack of reliable data and based on field observation, only 1/2 of the seasonal dwellings could be considered to be on septic systems and to be contributors of waste from a full range of appliances/sources. The other 1/2 of the seasonal residences was assumed to be utilizing pit toilets and sump pits for disposal of greywater. Greywater nitrogen and phosphorous contributions from the latter were calculated on the basis of contributions from sinks and baths only. Nitrogen and phosphorous loadings to the soil from pit toilets were considered, on a per capita basis, to be the same as contributions from a conventional toilet.

In order to be able to calculate comparable nitrogen and phosphorous soil loading values for the recreation sites, users were categorized as being 80% recreational vehicle campers and 20% tent campers. One hundred percent of the tent campers were assumed to utilize on-site pit toilets and to dump on-site amounts of greywater equivalent to kitchen sink contributions from residences. Of the recreational vehicle campers, 50% were assumed to utilize on-site pit toilets and to drain their kitchen wastes on-site.

In order to estimate actual loadings to the surface waters, the soil loadings were reduced by vertical transmissivity values to account for soil nutrient retention as waste effluent percolates downward. These values were then further reduced by horizontal transmissivity values to account for subsurface soil retention as the effluent moves downslope towards the surface waters. Transmissivity values calculated for similar soils for the adjacent Okanagan watershed were utilized in this study (Canadian Bio Resources Engineering Ltd., 1982). The vertical and horizontal transmissivity values utilized varied for differing soil/ topographic conditions.

2.5 Estimates of Potential Nitrogen and Phosphorous Loadings to Surface Waters

Taking into account the number of lots in proposed subdivisions, as well as the number of currently vacant lots, the potential number of new residences was calculated. Based upon current settlement patterns, likely locations of the potential additional residences were plotted on a 1:6000 scale planimetric map. These dwellings were then categorized as to distance classes from surface waters and type of soils. Proportions of permanent/seasonal dwellings currently evident, were utilized to estimate the potential number of permanent/seasonal residences. Using this data and current estimated nitrogen and phosphorous loadings, total potential contributions were estimated.

Potential loadings from the recreation sites were derived on the basis of an estimated 30% increase in use. This amount is approximately equal to the maximum annual use recorded in user surveys.

3.0 RESULTS

3.1 Soil Constraints for Septic Tank Use

Field survey results revealed that the study area is dominated by relatively coarse textured soils (gravelly loamy sands), with relatively high proportions of rounded coarse fragments (40-60%). For purposes of this study two major categories of soils have been described. The dominant soil is derived from fluvioglacial and fluvial surficial materials, is relatively coarse textured, deep, rapidly drained, and permeable. It is typical of soils described for the Hennings and Thalia soil map units (Lord and Greene, 1974) and is referred to in Tables 3 to 6 as HE - TH. The second type of soil extensively utilized for residences in the study area occurs on the lower slope portions of fluvial fans. It has relatively coarse textures typical of Thalia soils, but has seasonally high water tables rising to within 60 - 120 cm of the soil surface. It is considered a variant of Thalia soils and is referred to in the subsequent tables as TH. Imperfectly to very poorly drained floodplain and organic soils are relatively extensive in the study area, but have only rarely been utilized for residences. Results of two percolation rate tests for typical HE - TH soils, 2.5 and 3.8 minutes per 2.54 cm, suggest only a slight constraint for septic tank use (Table 1). However, other reported results for the area (<1 min/2.54 cm) and the physical characteristics of the soil, suggest that a moderate constraint rating is more appropriate. The latter value was utilized in this study.

On the attached Soil Constraints for Septic Tank Use Map, map units with relatively flat topography and deep soils above water tables or bedrock, have been rated as having only moderate constraints for septic tank use (Constraint Class 2 with relatively high permeability, relatively high coarse fragment content and rapid soil drainage constraints). It is important to note however, that the units depicted on the map are landform units and in many cases, extend to the edge of a surface waterbody/watercourse. In such cases, despite favourable soil properties, a unmapped 30 m set back from the edge must be considered unsuitable for septic tank use in light of current health regulations.

TABLE 1 Soil Constraints for Subsurface Septic Tank Effluent Absorption (after Epp, 1984).

CONSTRAINT	CONSTRAINT CLASS[1]			
Soil or Site Property[2]	Slight (1)	Moderate (2)	Severe (3)	Very Severe (4)
Percolation Test Rate (Perneability) (P)	2.5-15 min/ 2.54 cm	15-30 min/ 2.54 cm or 1.0-2.5 min/ 2.54 cm	30-60 min/ 2.54 cm or <1.0 min/ 2.54 cm	>60 min/ 2.54 cm
Topography (T)	0-9% slopes	10-15% slopes	15-30% slopes	>30% slopes
Depth to Bedrock (R)	>200 cm	120-200 cm	60-120 cm	<60 cm
Depth to Other Restrictive Layers (L)	>200 cm	120-200 cm	60-120 cm	<60 cm
Depth to Groundwater (W)	>200 cm	120-200 cm	60-120 cm	<60 cm
Flooding (F)	none	rare (<1 in 200 year interval)	occasional (between 1 in 20 and 1 in 200 year interval)	frequent (>1 in 20 year interval)
Soil Drainage (D)	well	moderately well rapid	imperfect	poor, very poor
Coarse Fragment Content (C)	0-20%	20-50%	>50%	---
Stoniness Class (S)	S0-S2 (0-3% stones)	S3 (3-15% stones)	S4 (15-50% stones)	S5 (>50% stones)
Soil Texture[3] (X)	sandy loam, loam, silt loam	silt,sandy clay loam, silty clay loam,clay loam, loamy sand	silty clay, clay, sandy clay, heavy clay	---

Areas of similar soils, but with steeper (15-30%) slopes have been rated as having severe constraints (Constraint Class 3). Where slopes exceed 30%, the map units units have been rated as having very severe constraints (Constraint Class 4). For map units with TH soils (seasonally high water tables) Constraint Class 3 ratings have been applied. Floodplain and organic soils have all been mapped as Constraint Class 4 with high water table, flooding and poor soil drainage constraints.

3.2 Soil Suitability for Septic Tank Use

Map units with a Constraint Class 2 rating and deep soils above water table or bedrock are shown in Table 2 as having a High Suitability for septic tank use (except for the 30 m setback from surface waters, noted above). Where water tables are seasonally closer to the surface (120-200 cm), or where slopes are in the range of 15 to 30%, the suitability class is limited to Moderate. All other map units with steeper slopes (>30%), seasonally high water tables (within 60-120 cm of the surface), or flooding, have been rated as having Low Suitabilities.

TABLE 2 Soil Suitability Ratings for Septic Tank Waste Disposal Systems.

Soil Suitability Class	Soil Constraints Classes (see map)
High	2^{PDC}
Moderate	2^{PWD}, 3^{T}_{PD}, 3^{T}_{WP},
Low	3^{FW}_{P}, 3^{F}_{DC}, 3^{W}_{PD},
	4^{TR}, 4^{T}_{PW}, 4^{T}_{PD},
	4^{W}_{PD}, 4^{WFD}, 4^{F}_{PW}

3.3 Number of Residences

The number of permanent and seasonal residences and the number of camper days use for all three recreation sites is shown in Table 3. Seventy- two percent of the residences are seasonal. Sixty-six percent of residences, plus all three recreation sites are in the <60 m distance from surface waters category. Most of these are on relatively small lots (<0.5 ha). Field and air photo observation further suggests that most of this 66% are immediately adjacent (<30 m setback) to surface waters. Residences within the 60-12- m zone are more commonly on intermediate sized lots (0.5-1.0 ha). The residences >120 m back are generally on larger lots (>1 ha) and are usually well isolated from surface waters. Compared to the seasonal residences, a relatively high proportion of their permanent residences are in the 60-12- m and > 120 m distant from surface waters zones.

TABLE 3 Number of Residences and Number of Camper Days for Recreation Sites.

Soil Association	Number of Residences						Number of Camper Days per Year
	Permanent			Seasonal			
	<60 m	60-120 m	>120 m	<60 m	60-120 m	>120 m	<60 m
HE-TH	13	9	9	68	17	7	6660
TH	16	1	0	24	8	2	0

3.4 Population Equivalents

When adjusted for number of residents and length of use per year, the data in Table 4 suggest that the larger number of seasonal residences make up only an equivalent of 34% of the number of sewage effluent contributors. The recreation sites equivalent value (annual basis) is only 5%. It may be important to note, however, that sewage loadings from seasonal dwellings and recreation sites (a high proportion of which are near surface waters) are concentrated into the June 15 to September 1 season, a period of high level of biological activity in the lakes. The effect of this seasonal peak loading may, however, be reduced somewhat by the natural summer reduction of subsurface water flow.

TABLE 4 Population Equivalent Values for Waste Disposal, Annual Basis.

Soil Accoc-iaton	Equivalent Annual Population Contributing Waste						
	Permanent Residences			Seasonal Residences			Recreation Sites
	<60 m	60-120 m	>120 m	<60 m	60-120 m	>120 m	<60 m
HE-TH	39	27	27	42.6	10.6	4.4	10.8
TH	48	3	0	15.0	5.0	1.2	0.0

3.5 Nitrogen and Phosphorous Soil Loadings

Table 5 depicts the estimated quantities of nitrogen and phosphorous supplied (annual basis) to the soil from permanent residences (63% for N, 68% for P), seasonal residences (33% of the N, 29% of the P) and recreation sites (4% for N and 3% for P). It is significant to note that despite the apparent heavy seasonal use by the large number of seasonal residences and the heavy seasonal use of the recreation sites, that 2/3 of the estimated annual nutrient loading comes from only 28% of the contributors, those occupying permanent residences. This is, no doubt, a reflection of the heavier use of appliances such as dishwashers and washing machines in permanent residences.

TABLE 5 Estimated Nitrogen and Phosphorous Soil Loading.

Soil Accoc-iaton	Nutri-ent	Kg./Yr. Soil Loading						
		Permanent Residences			Seasonal Residences			Recreation Sites
		<60 m	60-120 m	>120 m	<60 m	60-120 m	>120 m	<60 m
HE-TH	N	150.9	104.5	104.5	155.6	38.7	16.1	37.6
	P	56.9	39.4	39.4	48.8	12.1	5.0	9.2
TH	N	185.8	11.6	0.0	54.8	18.3	4.4	0.0
	P	70.8	4.4	0.0	17.2	5.8	1.4	0.0

3.6 Nitrogen and Phosphorous Contributions to Surface Waters

When nitrogen and phosphorous soil loadings are reduced to account for soil retention, estimated loadings reaching the surface waters are reduced by 34% for nitrogen and 55% for phosphorous. The 21% difference for the two nutrients being due to a higher transmissivity for nitrogen. Estimated quantities (annual basis) of the two nutrients supplied to surface waters are given in Table 6 as 570.3 kg/yr for nitrogen and 139.8 kg/yr for phosphorous. It should be emphasized, however, that entry of these nutrients into the surface waters is not evenly distributed, discharges being concentrated in areas of the greatest number of dwellings (especially the permanent dwellings adjacent to the lake), in areas of greatest subsurface flows (such as fluvial fans) and finally, being concentrated in the summer.

Murphy and Urciuoli (unpubl.) using methodologies developed in Ontario to evaluate waste contributions from cottages, estimated annual phosphorous contributions to Chain Lake from septic sources to be approximately 29.3 kg/yr. A estimate from this study, based on a 28% increase in number of residences since their study, and using the described methodology, is 38.7 kg/yr. Murphy and Urciuoli describe Chain Lake as a lake subject to eutrophication, rich in phosphorous, with nitrogen likely being the nutrient limiting algal growth. They estimate natural external phosphorous loading to the lake from streams and subsurface flow to be 96 kg/yr. They estimate a very high seasonal loading of 568 kg/yr within the lake due to release of phosphorous from lake sediments. As a consequence, they suggest that in terms of total phosphorous budget, that for this lake, that contributions from septic sources are relatively insignificant. However, they speculate that effluent contributions of nitrogen and organic carbon may be significant, providing that the quantities are not grossly overshadowed by the production of carbon and fixation of nitrogen by algae in the lake.

TABLE 6 Estimated Present and Potential Nitrogen and Phosphorous Contributions to Surface Waters.

Soil Association	Nutrient	Present/Potential Contrib's	Kg./Yr. Loading to Surface Waters: Permanent Residences			Seasonal Residences			Recreation Sites	Totals	
			<60 m	60-120 m	>120 m	<60 m	60-120 m	>120 m	<60 m	N	P
HE-TH	N	Present	86.0	59.6	17.9	88.7	22.1	2.8	21.4	298.5	
	P		16.2	8.9	3.5	13.9	2.7	0.4	2.6		48.2
TH	N	Present	185.8	11.6	0.0	54.8	18.3	1.3	0.0	271.8	
	P		67.3	3.3	0.0	16.3	4.3	0.4	0.0		91.6
										570.3	139.8
HE-TH	N	Potential	119.1	132.4	101.4	118.7	49.4	16.0	27.8	564.8	
	P		22.4	19.8	19.8	19.0	7.6	2.3	3.4		94.3
TH	N	Potential	325.1	11.6	0.0	98.2	18.3	1.3	0.0	454.5	
	P		117.8	3.3	0.0	29.2	4.3	0.4	0.0		155.0
										1019.3	249.3

Table 7 summarizes approximate ranges of values for total nitrogen and phosphorous and dissolved nitrogen and phosphorous from mid lake water samples taken in the summer (April-August) and fall (September-October) at 0 to 4 m depths for Chain, Link and Osprey Lakes (Water Investigations Branch graphs 1977, 1977, 1978). This data shows that Chain Lake is the most nutrient rich of the three, especially for dissolved phosphorous (5 to 10 times greater than for Link or Osprey) and total phosphorous (2 to 10 times greater). Total nitrogen values are similar for all lakes in the summer, but ranges are 1.5 to 3 times greater at Chain Lake in the fall. Dissolved nitrogen values range from similar to 3 times greater in Chain vs. Link and Osprey Lakes. The data show that Osprey is the least eutrophic of the three. The previously discussed nutrient data would appear to support the conclusion that for Link Lake and even more so for Osprey Lake, with their greater density of permanent and seasonal residences, in large part located on fans subject to subsurface water flow, and in large part near lake edge, that effluent inputs from septic tanks will have a more significant impact in terms of total nutrient budget, than at Chain Lake.

TABLE 7 Ranges in Total Nitrogen and Phosphorous, and Dissolved Nitrogen and Phosphorous, in Water Samples from Chain, Link and Osprey Lakes.

Nutrient	Season	mg/1 concentration		
		Chain L.	Link L.	Osprey L.
Dissolved N	Summer Fall	0.02 - 0.14 0.00 - 0.22	<0.02 - 0.03 <0.02 - 0.04	<0.02 - 0.10 0.02 - 0.11
Total N	Summer Fall	0.2 - 0.7 0.7 - 1.5	0.3 - 0.65 0.5 - 1.2	0.4 - 0.45 0.35 - 0.40
Dissolved P	Summer Fall	0.025- 0.05 0.05 - 0.125	0.003 - 0.008 0.003 - 0.020	<0.003 0.003
Total P	Summer Fall	0.11 - 0.15 0.13 - 0.17	0.015 - 0.052 0.040 - 0.075	0.010 - 0.015 0.015

3.7 Potential Nitrogen and Phosphorous Contributions to Surface Waters

The total estimated potential nitrogen and phosphorous contributions to surface waters given in Table 6 reveal a predicted 45 and 44% increase in nitrogen and phosphorous loadings, should the area become fully developed. These increased quantities would, in this author's opinion, significantly enrich the nitrogen and phosphorous budgets of Link and Osprey Lakes. To a lesser extent, Chain Lake would also be pushed towards full eutrophic status.

4.0 DISCUSSION

A number of alternatives are possible to reduce the inputs of septage effluent into the study areas surface waters. Restriction of lots to larger sizes and requirements for more lengthy set backs are obvious proposals, but are difficult to put into practice within the existing framework of regulations, especially in already developed areas.

Improvements of Waste disposal methods is however, a viable alternative in many cases. For presently existing, or proposed residences located proximate to surface waters, or on high water table areas, collection of septage in a sump and pumping it to a field more removed or at a higher elevation, is a viable and relatively inexpensive option. Where residences are closely clustered and where the necessary regulation, organization and maintenance can be established, septage from a number of residences can be collected and pumped upslope, or further back to larger fields on vacant lots. For seasonal lots only utilized in the snow free seasons, sealed bed evaporative systems are a viable alternative, particularly for high water table areas. However, unless regulations could be established to restrict the use of such residences to seasonal only, they would also require installation of conventional septic tank/field systems for winter use. Use of raised bed septic fields constructed from imported materials is not recommended for the study area (especially for high water table areas) by this author, unless a comprehensive effluent disposal study can establish that off-site pollution/nutrient loading will not occur. Particularly on high water table areas, the use of water saving devices, such as "suds savers" on washers, and composting, electric or chemical toilets should be encouraged.

5.0 REFERENCES

Canadian Bio Resources Engineering Ltd. 1982. 1980 Update, nutrient loadings from non-point sources. Okanagan Basin Implementation Board, 17-18.

Environmental Protection Agency. 1977. Alternatives for small wastewater treatment systems. On-site disposal/septage treatment and disposal. Technology Transfer Seminar Publication, United States, 27-47.

Environmental Protection Agency. 1980. Design manual. Onsite wastewater treatment and disposal systems. Office of Water Program Operations, United States, 56-58.

Epp, P.F. 1983. Estimates of phosphorous loading to Cultus Lake from domestic waste sources. Surveys and Resource Mapping Branch, Ministry of Environment, Province of British Columbia, 20 pp.

Epp, P.F. 1984. Soil constraints for septic tank effluent absorption. Ministry of Environment Manual 5, Surveys and Resource Mapping Branch, Ministry of Environment, Province of British Columbia, 90 pp.

Lord, T.M. and A.J. Green. 1974. Soils of the Tulameen area of British Columbia. Report No. 13 of the British Columbia Soil Survey, Research Branch, Canada Department of Agriculture, 163 pp.

Murphy T.P. and D. Urciuoli. Unpublished. Limnological observations of Chain Lake. Aquatic Ecology Division, National Water Research Institute, National Water Research Institute, Canada Centre for Inland Waters, 46 pp.

Wiens, J. 1983. Estimates of phosphorous inflow to Tie Lake. Surveys and Resource Mapping Branch, Ministry of Environment, Province of British Columbia, 13 pp.

Water Investigations Branch. 1977. Observations on the water quality in the Chain-Link-Osprey Lakes system. Part 1. Water quality data for Chain Lake and discussion of the effectiveness of the Shinish Creek diversion. Ministry of Environment, Province of British Columbia, 79 pp.

Water Investigations Branch. 1977. Observations on the water quality in the Chain-Link-Osprey Lakes system, Princeton, B.C., 1973-1976. Part 2. Water quality for Link Lake. Environmental and Engineering Services, Ministry of Environment, Province of British Columbia, 50 pp.

Water Investigations Branch. 1978. Observations on the water quality in the Chain-Link-Osprey Lakes system, Princeton, B.C., 1973-1976. Part 3. Water quality for Osprey Lake. Ministry of Environment, Province of British Columbia, 66 pp.

Table 6

Estimated Present and Potential Nitrogen and Phosphorous Contributions to Surface Water

Lake	Soil	Nutrient	Present/ Potential Contrib'n	Kg/yr. loading to surface waters: Permanent Residences <60m	60-120m	>120m	Seasonal Residences <60m	60-120m	>120m	Rec Sites <60m	Totals: Present N	P	Potential N	P
Chain L.	HE-TH	N	Present	39.8	19.8	0.0	32.5	5.2	0.4	8.9	106.6			
	"	P	"	7.0	2.8	0.0	4.2	0.5	0.05	0.7		15.2		
	TH	N	"	11.6	0.0	0.0	9.1	0.0	0.0	0.0	20.7			
	"	P	"	4.2	0.0	0.0	2.4	0.0	0.0	0.0		6.6		
	HE-TH	N	Potential	53.1	26.4	2.0	39.4	7.8	0.8	11.6			140.7	
	"	P	"	9.3	3.7	0.4	5.0	0.7	0.1	0.9				20.4
	TH	N	"	11.6	0.0	0.0	11.3	0.0	0.0	0.0			22.9	
	"	P	"	4.2	0.0	0.0	3.0	0.0	0.0	0.0				7.2
											127.3	21.8	163.6	27.6
Little L.	HE-TH	N	Present	13.2	19.8	0.0	16.9	12.9	0.0	5.5	68.3			
	"	P	"	2.3	2.8	0.0	2.2	1.3	0.0	0.4		9.0		
	TH	N	"	23.2	0.0	0.0	11.3	0.0	0.0	0.0	34.5			
	"	P	"	8.4	0.0	0.0	3.0	0.0	0.0	0.0		11.4		
	HE-TH	N	Potential	39.6	46.2	29.7	29.9	25.8	6.0	7.1			184.3	
	"	P	"	6.9	6.5	5.5	3.9	2.6	0.7	0.5				26.6
	TH	N	"	69.6	0.0	0.0	49.7	0.0	0.0	0.0			119.3	
	"	P	"	25.2	0.0	0.0	13.2	0.0	0.0	0.0				38.4
											102.8	20.4	303.6	65.0
Osprey L.	HE-TH	N	Present	26.4	13.2	9.9	18.1	7.5	1.6	6.3	78.0			
	"	P	"	4.7	1.8	1.8	2.3	0.3	0.2	0.5		11.6		
	TH	N	"	150.9	11.6	0.0	54.9	18.3	0.0	0.0	235.7			
	"	P	"	54.1	3.3	0.0	14.4	3.7	0.0	0.0		75.5		
	HE-TH	N	Potential	39.6	26.4	23.8	22.0	6.2	4.0	8.2			130.2	
	"	P	"	7.1	3.6	4.3	2.8	0.7	0.5	0.6				19.6
	TH	N	"	185.7	23.2	0.0	66.3	22.9	0.0	0.0			298.1	
	"	P	"	66.6	6.6	0.0	17.7	4.6	0.0	0.0				95.5
											313.7	87.1	428.3	115.1
Tributary streams	HE-TH	N	Present	19.8	13.2	7.9	5.2	1.3	0.7	0.0	48.1			
	"	P	"	3.5	1.8	1.5	0.7	0.1	0.1	0.0		7.7		
	TH	N	"	11.6	11.6	0.0	4.4	2.2	0.2	0.0	29.8			
	"	P	"	4.2	3.3	0.0	1.1	0.4	0.0	0.0		9.0		
	HE-TH	N	Potential	39.6	19.8	33.6	11.7	5.2	3.5	0.0			113.4	
	"	P	"	7.0	2.7	6.4	1.6	0.4	0.5	0.0				18.6
	TH	N	"	23.2	11.6	0.0	6.6	2.2	0.0	0.0			43.6	
	"	P	"	8.4	3.3	0.0	1.6	0.4	0.0	0.0				13.7
											77.9	16.7	157.0	32.3
										Totals all lakes	621.7	146.0	1052.5	240.0