1977 BELWOOD RESERVOIR
A PRELIMINARY WATER QUALITY SURVEY

Prepared by: P. Mason, Aquatic Biologist
Water Management Division
Biological Studies Group

Participants: J. Bartlett
B. Hindley
D. Leslie
B. Rayner
W. Yerex

TABLE OF CONTENTS

A. HISTORY AND OPERATION OF BELWOOD RESERVOIR

Shand Dam on the Grand. River upstream of Fergus, Ontario, approximately 140 miles from the mouth of the Grand at Lake Erie was completed in 1942 as a flood control and river regulation dam. It is an earthfill-type structure which is 78 feet in height and 2,100 feet long. The concrete gravity spillway section is capable of discharging 60,000 c.f.s. through its four crest gates which are 30.5 feet high by 30 feet wide. The reservoir capacity is 51,788 acre-feet at 1395.6' ASL which is approximately 1921 surface acres. The drainage area of the dam is 308.5 square miles. The following table points out some information of interest.

Elevation	Item	Storage (acre-feet)	Surface Area Acres
1400.0	Top of Dam		
1395.6	Max. Water Level	51,788	1,921
1354.6	Top of Gates	49,845	1,874
1364.0	Spillway Sill	9,444	780
1340.25	Centre line of 48" valves	345	76
1326.25	Centre line of 66" valve	0	0

On the basis of current and projected demands downstream for water supply and flow maintenance a discharge regime is established by the Grand River Conservation Authority. The normal drawdown for early summer is approximately 150 acre-feet per day. During late summer and early fall the drawdown is approximately 300 acre-feet per day. It is imperative that drawdown follows on a regular basis so that sufficient storage is provided for late summer and fall, hurricane generated storms.

As an ancillary benefit to the construction of Shand Dam is the recreation potential provided. To date, there are approximately 355 cottages surrounding the lake, at least 6 privately maintained campgrounds, also private boat launching facilities, a sailing club, a small Authority run swimming and beach area, and boat ramp in 1977 approximately 39,000 people entered the park for day use activities.

B. SUMMARY OF WATER QUALITY AT BELWOOD RESERVOIR

Water quality entering the reservoir is in a slightly enriched state. Nutrients are entering in quantities sufficient enough to allow for nuisance algal growth. Nutrients appear to rise steadily throughout the reservoir indicating sources of enrichment within the reservoir. Nutrients leaving the reservoir are greater than those entering but less than values recorded within the reservoir, which indicates a buildup of nutrients within the reservoir.

Downstream water quality is different than inflowing water quality, but not necessarily poorer.

	AVERAGE VALUES	
	Upstream	Downstream
Dissolved Oxygen (mg/L)	8.92	9.36
Water Temperature (°C)	18.60	16.40
Biochemical Oxygen Demand (mg/L)	1.72	1.81
Alkalinity (mg/L)	174.0	194
Calcium Hardness (mg/L)	189.4	194
Total Hardness (mg/L)	125.0	136
pH	8.26	8.05
Nitrate (mg/L)	0.4	0.55
Total Phosphates (mg/L)	0.26	0.38
Sulfates (mg/L)	16.6	15.8
Iron (mg/L)	0.06	0.08
Flow (average of days of sample collection)	80 cfs	150 cfs

As can be seen in the above table, there is very little difference between upstream and downstream water quality parameters with the exception of flow. There are a number of causes that contribute to the mesotrophic status of Belwood Reservoir. The primary cause is the nutrient laden spring waters that enter the reservoir. Secondary aspects associated with enrichment of Belwood Reservoir are day use activities, cottage use, camping and boating among others. Downstream water quality could be improved (with regard to nutrients) if there was not a significant input to the reservoir. This study also revealed that the reservoir did stratify to a mild degree during the summer but in spite of bottom drawoff did not have a detrimental effect downstream.

C. RECOMMENDATIONS

1. That water quality be monitored at the reservoir on a continual basis.

2. Loadings to the reservoir should be seriously studied.

3. An effort should be put forward to determine if use within a reservoir has an effect on downstream water quality. To this end, a carrying capacity for the reservoir may be designed.

D. BELWOOD RESERVOIR WATER QUALITY ANALYSIS

Introduction

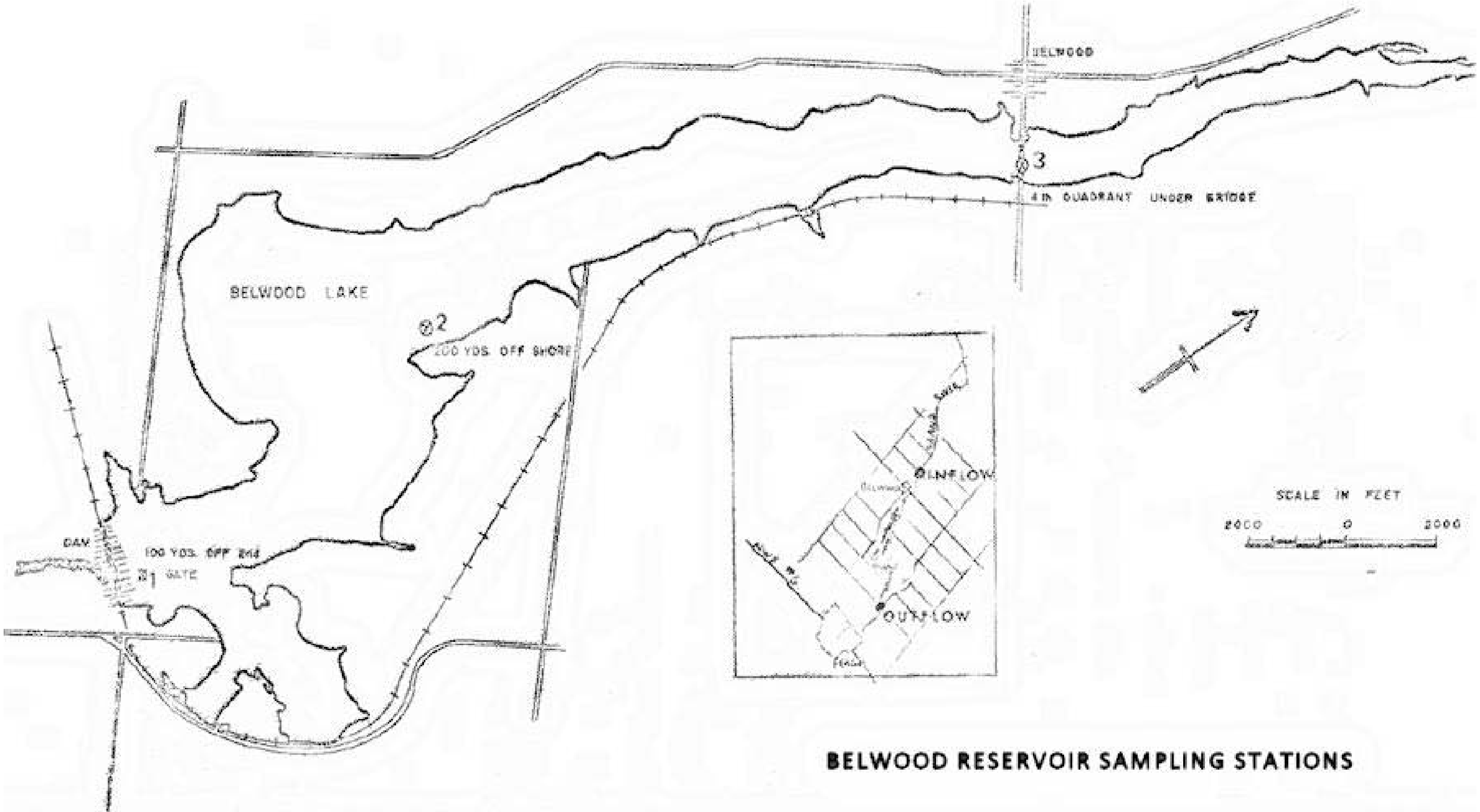
Of most importance in any analysis of a reservoir is to determine its effect on the downstream water quality. It must be pointed out, however, that the effects or benefits of low flow augmentation are not realized immediately downstream of a reservoir (within a mile). Those benefits are felt much farther downstream, The study at Belwood Reservoir compares the effects immediately downstream. The following format is arranged to contrast inflowing. water and outflowing water. The 3 reservoir stations are discussed separately with specific reference to the change in conditions of inflow water and the reservoir effect on water quality downstream.

Station Location (Condition)

The map on page 6 delineates the sampling stations. The inflow station was located on Concession VIII + IX north of the Town of Belwood. The substrate at this location is largely sheets of bedrock with some isolated areas of boulders and smaller stones. Cattle are able to walk easily into the river at this point since the floodplain is quite wide here and there is virtually no slope on the southeastern banks. Flow here varied quite a bit from 3 cfs to 572 cfs. The outflow station located on the first concession downstream of the dam has a similar substrate structure to that of the inflow with the exception that there is more broken limestone or bedrock pieces interspersed throughout. The stream banks are well vegetated and no cattle can gain access to the river for some distance downstream.

Flow below the dam is far more constant than the inflow being approximately 100 cfs to mid-June, 125 cfs to mid-July, 120 cfs to late August and over 200 cfs through September.

Three reservoir stations were established. Station #1 was approximately 100 m off the dam, Station #2 was approximately mid-reservoir at the point where the reservoirs first narrows, and station 3 was under the bridge at the town of Belwood. Samples were collected one metre from the surface and one metre from the bottom at each reservoir station. Station 1 was the deepest being 17.5 m, station 2 was 10 m, and station 3 was 7.25 m deep.



BELWOOD RESERVOIR SAMPLING STATIONS

i) Water Quality Analysis: Inflow

Water quality entering Belwood Reservoir is fairly good. Of the 19 times collections were made, Dissolved Oxygen exceeded 9.0 mg/L on 9 occasions. There appeared to be very little variation in Dissolved Oxygen, the range being 7.3 mg/L to 10.8 mg/L. Although regression analysis showed a positive relationship between Dissolved Oxygen and flow it was not significant. In other words, if flow increased, Dissolved Oxygen did not necessarily increase. Water Temperature was also not affected to any great degree by the flows over the summer but appeared to be related more so to air temperature. Nevertheless the average water temperature was 18.6°C with a maximum of 24.5°C. The BOD_5 indicates slight enrichment averaging 1.72 mg/L throughout the summer with a maximum of 2.7 mg/L in mid-August and a minimum of 0.15 mg/L in mid-fall. Highest BOD's are generally noticed in the Spring due to the runoff. Measurements were not made during that period.

Mid-summer tends to be the time of the year a stream is under its greatest stress due to lower flows and higher air temperatures. Total and Faecal Coliforms varied sporadically throughout the summer and only a few times did the values exceed established criteria. This data indicates that there is not a conform problem upstream of Belwood Reservoir. The influence of Grand Valley has been dissipated before this point, so that the only source would be through soil bacteria, wildlife and cattle usage of the stream.

Alkalinity, Total Hardness, Calcium. Hardness and pH

Alkalinity is a measure of the waters buffering ability or capacity. Water alkalinity is a result of the type of geologic formations through which the water course passes. Because of the significant limestone formations in the Upper Grand the water tends to have a high alkalinity. This results in a great buffering capacity which protects the pH of the water. If a significant amount of acid should be put into the water it is unlikely that the pH would change to any great degree but the alkalinity would. These four factors, Alkalinity, Total Hardness, Calcium Hardness, and pH are all interrlated and are related to the geology of the area. The pH at this point is very basic. The recreational criteria is 6.5 to 8.3. Measurements at this site revealed that 8.3 was equalled or exceeded on 8 of 19 occasions sampled. Very little variation occured in Total Hardness and Calcium Hardness throughout the sampling period, however, the water is extremely hard, again due to limestone and bedrock formations of the valley. During periods of high flows alkalinity increased but it wasn't necessarily true for hardness.

Nitrate, Nitrogen and Total Phosphate

Both these parameters exceed criteria that limit nutrient input for purposes of reducing eutrophication. it is generally accepted that values exceeding 0.01 mg/L as Phosphorus and 0.3 mg/L as Nitrates will increase the trophic status of an impoundment. As these parameters increase an impoundment status goes through the stages of eutrophication (from oligotrophic to eutrophic). The average input of nitrates and phosphates to the reservoir are significant since they will provide sufficient nutrients to promote aquatic weed growth (specifically algae). This will have an effect on water clarity, Dissolved Oxygen and bottom waters. Of significant interest is the fact that more phosphorus and nitrogen is leaving, the reservoir than entering. This aspect will be discussed under the reservoir section.

Sulfates and Iron

Should significant amounts of these two items enter the reservoir, they will have an adverse effect on reactions in the reservoir. Under anoxic conditions in the reservoir (which didn't exist at Belwood) sulfates act as an oxygen source for bacteria which convert the sulfates to hydrogen which is noticeable by its foul odour should the bottom waters become exposed. High iron will affect the retention time and release mechanisms of phosphorus components in the lake sediments. The range of sulfates in natural waters is between 10-80 mg/L but will be increased due to industrial discharge. Sulfates in the Grand above Lake Belwood fall within this range being 10 - 16 mg/L with no great variation during the sampling period. Iron is one of nature's most abundant metals and is generally found in low levels in antural surface waters because of the low solubility of the ferric iron when the pH of the water exceeds 7.0. Iron presents no problem.

Flow

Many parameters vary with flow, but in many cases a significant positive relation was not illustrated. Alkalinity and Phosphates showed a correlation coefficient of 0.64 and 0.52 respectively which makes sense since as flow increases a wider floodplain is created therefore covering more surface and generally higher flows are associated with greater runoff themore leaching of the soils and contaminant input as with phosphates. The flow throughout the summer was rather erratic varying from 3 to 572 c.f.s. August and September were fairly wet months compared to the early summer therefore flows were greater during these two months.

BELWOOD LAKE STATION: INFLOW DEPTH: TOP

DATE 1977	DO	WT	BOD	SEC	COL T/F	ALK	TH	CaH	pH	NO_3	PO_4	SO_4	Fe	AT °C	Wea	D (m)
May 17	9.9	19.5	2.025		24/1	180	195	125	8.4	0.99	0.05	17	0.15	29	1	
May 24	10.1	23	1.1		50/39	270	190	115	8.5	0.30	0.09	19	0.03	25	1	
May 31	8.1	18.5			2/14	185	180	100	7.5	0.15	0	12	0	24	1	
June 7	9.5	12	1.3		23/16	180	210	100	8.2	0.80	0.10	18	0	7	1	
June 14	8.3	19	1.95		56/56	160			8.2	0.2	0.08	18	0.05	21	1	
June 21	9.6	18	2.3		104/6	155			8.2	0.3	0.11	15	0.10	18.5	1	
June 28	8.7	23.5	1.35		28/230	160			8.4	0.3	0.10	11	0.10	28	1	
July 5	7.5	24.5	2.05		40/0	130	150	110	8.4	0.3	0.10	14	0.05	26.5	1	
July 12	7.9	22	1.1		32/38	155			8.2	0.4	0.10	16	0.05	23	2	
July 19	8.2	24	1.45		0/TNC	140			8.4	0.2	0.30	12	0.18	24	2	
July 26	9.5	18	1.8		16/80	140			8.5	0.5	0.48	10	0.10	17.5	1	
Aug.4	8.6	20.5	2.7		90/126	105			8.6	0.4	0.15	14	0.04	23	1	
Aug.9	7.5	19	1.05		TNN/TNC	160	185	130	8.4	0.5	0.43	16	0.10	24	1	
Aug. 16	7.3	17.5	1.85		4/62	150			8.1	0.5	0.12	13	0	13	2	
Aug. 23	9.0	16.5	1.8		40/90	190			8.2	0.3	0.63	34	0.10	22	1	
Aug. 30	9.0	19	2.5		30/40	190			8.3	0.2	0.40	24	0.10	22	1	
Sept. 6	10.8	17	2.25		80/26	210			8.2	0.5	0.75	22	0.05	18	2	
Sept. 13	9.5	16	2.15		TNC/25	180	190	130	8.0	0.3	0.30	15	0.05	14	3	
Oct. 19	10.5	6.5	0.15		46/22	275	215	190	8.2	0.5	0.60	16	0	7	2	
MAX.	10.8	24.5	2.7		TNC/TNC	275	215	190	8.6	0.99	0.75	34	0.18			
AVE.	8.92	18.6	1.72			174	189.4	125	8.26	0.4	0.26	16.63	0.066			
MIN.	7.3	6.5	0.15			105	150	100	7.5	0.2	0.05	10	0			
# SAMPLES	19	19	19			19	19	8	8	19	19	19	19			

DO	Dissolved Oxygen	TH	Total Hardiness	AT	Air Temperature	Weather Code	
WT	Water Temperature	CaH	Calcium Hardness	Wea	Weather	1 -	Sunny
BOD_5	Biochemical Oxygen Demand.	pH	pH	D	Depth	2 -	Cloudy
SEC	Secchi Disc	NO_3	Nitrate Nitrogen			3 -	Precipitation
COL	Total Coliforms	PO_4	Phosphate				
	Faecal Coliforms	SO_4	Sulfate				
ALK	Alkalinity	Fe	Iron				

ii) <u>Water Quality Analysis: Outflow</u>

Dissolved Oxygen and Water Temperature

Dissolved Oxygen below Belwood Reservoir is very good. During the sampling period the average Dissolved Oxygen was 9.4 mg/L with a maximum and minimum of 11.0 mg/L and 7.4 mg/L respectively. Of 19 times sampled, Dissolved Oxygen exceeded 9.0 mg/L 12 times. Water is withdrawn from the reservoir at 1340.65' or approximately 14.5 m below the surface of the reservoir. As will be seen in the reservoir section, Dissolved Oxygen at that level was below 1.0 mg/L from July 12 to August 9 and also on September 6. The downstream Dissolved Oxygen does not reflect this low Dissolved Oxygen as is shown in the following table:

	Units - mg/L	
	Lake (1340.65')	Downstream
July 12	1.0	8.3
July 26	1.0	9.6
Aug. 9	1.0	8.0
Sept. 6	1.0	10.6

Obviously the re-aeration is rapid to this point. The Water Temperature does, however, correspond directly with the level of discharge although there is a slight warming noticeable in the early summer. The following table contrasts the Water Temperature of the downstream station, 1340.0 reservoir level and surface at reservoir station #1 and the inflow station.

Temperature (°C)

		Outflow	Reservoir		Inflow
			Surface	(1340.65)	
June	14	13	16.5	11	19
	28	17	20.5	14.5	23.5
July	12	19	20	16.5	22
	26	17.5	21.5	18.5	18
Aug.	9	17	21.5	20.5	19
	23	17	18	17	16.5
Sept.	6	18	20.5	18	17
	13	17	18	18	16
Oct.	9	7	8	7	6.5

There is a lag or delay in Water Temperatures downstream in comparison to the upstream location of close to two months, in the sense that from May 17 to July 26 the inflowing water is noticeably warmer than outflow. After that period the differences are only ±0.5°C to 1°C. By midsummer the reservoir surface stations are warmer than either inflow or outflow but because of the bottom drawoff nature, Water Temperatures downstream are considered to be cold water (less than 20°C).

BOD_5

There exists only a marginal increase in average BOD over the upstream station, but a larger range.

BOD_5 (mg/L)	Upstream	Downstream	Reservoir Stn. #1 Bottom
Average	1.72	1.81	1.97
Maximum	2.70	3.60	4.45
Minimum	0.15	0.05	0.05

The above chart indicates only a 0.09 mg/L increase over approximately 10 miles. If one were not aware of the fact that a reservoir separates these two stations this slight increase could only be attributed to a natural increase in loading as the river progresses downstream. Based on this one parameter alone, one could not say that the reservoir contributes greatly to poorer water quality downstream.

Total Coliforms & Faecal Coliforms

Of the 29 times Total and Faecal Coliforms were collected Total exceeded once and Faecal exceeded 5 times. The upstream station exceeded 2 sand 4 times respectively. Some of this contamination could be related to the reservoir water quality but it is more likely that it occurred from the banks and waterfowl usage below the dam.

Alkalinity, Total Hardness, Calcium Hardness, pH

Alkalinity is slightly higher here than upstream. Alkalinity varied with flow upstream resulting in a range of 107 mg/L. Below the dam there was not an apparent relation between flow and alkalinity. The range was less than the inflow being 65 mg/L. Higher values were observed in late spring and early fall.

Total Hardness and Calcium Hardness indicate very hard waters and did increase slightly over the inflowing water.

The pH values revealed a small range of values and were more often less than 8.3 than were the inflowing values.

Nitrate, Nitrogen and Total Phosphates

One interesting fact revealed was that approximately 2 to 2½ times as much phosphates and nitrates were leaving Belwood Reservoir as were entering. This would indicate that there is a significant input directly to the reservoir. As will be shown in the reservoir section there is also a gradual increase in both parameters throughout the reservoir, which supports the conclusion that there is considerable contamination from within. This addition of excessive nutrients downstream will cause an adverse effect by allowing algal accumulation in areas of slow water flow. Some of this is evident downstream with the buildup of slime type algae on the bedrock surfaces.

Sulfates and Iron

The range of sulfates is certainly less here than the inflow and less is leaving. This may indicate occasional anoxic conditions in this reservoir, in the sense that the sulfates are providing oxygen for bacteria in the absence of Dissolved Oxygen. This may be stretching the point since the differences are not that great. Iron is certainly not a problem here with the maximum value being 0.1 mg/L. This may indicate little iron in the reservoir thereby allowing free movement of phosphorus compounds.

AREA: BELWOOD LAKE STATION: OUTFLOW DEPTH : TOP

DATE 1977	DO	WT	BOD	SEC	COL T/F	ALK	TH	CaH	pH	NO_3	PO_4	SO_4	Fe	AT °C	Wea	D (m)
May 17	10.6	15	0.9		9/6	185	190	135	8.0	1.2	0.15	18	0.05	29	1	
May 24	10.6	14	0.65		13/0	270	200	140	7.8	0.6	0.50	17	0	25	1	
May 31	9.6	12			11/4	200	190	140	8.1	0.2	0.20	16	0.30	27	1	
June 7	11.0	11.5	1.65		11/5	190	190	140	8.0	1.0	0	18	0.05	8	1	
June 14	10.2	13	2.95		10/2	190			8.0	0.4	0.30	14	0.10	18.5	1	
June 21	10.2	16	2.25		44/62	190			8.5	0.5	0.08	17	0.05	18	1	
June 28	9.4	17	1.85		36/12	200			7.8	0.7	0.30	14	0.05	24.5	1	
July 5	7.6	19	0.5		40/0	190	180	80	8.3	0.7	0.25	16	0.10	27	2	
July 12	8.3	19	1.3		72/8	190			8.1	0.7	0.11	17	0.18	22	2	
July 19	8.6	19.5	1.4		64/108	200			8.0	0.6	0.50	13	0.11	26	2	
July 26	9.6	18.5	3.3		12/30	190			8.2	0.4	0.42	14	0.15	18	1	
Aug. 4	8.3	20	2.15		200/124	190			8.0	0.5	0.10	14	0.10	23.5	1	
Aug. 9	8.0	20.5	1.0		TNC/190	185	185	145	8.2	0.5	0.20	12	0.02	22	1	
Aug.16	7.4	19	1.8		4/110	180			8.1	0.5	0.29	13	0.05	14.5	2	
Aug. 23	9.4	17	3.6		42/44	175			8.0	0.9	0.70	20	0.20	18.5	1	
Aug. 30	8.8	18	2.0		114/50	175			8.1	0.6	0.90	17	0.10	18	1	
Sept. 6	10.6	18	2.3		42/58	175			7.8	0.4	0.80	16	0	18	2	
Sept. 13	9.4	17	2.9		40/400	180	180	135	8.0	0.3	0.50	17	0.05	14	3	
Oct. 19	10.2	7	0.05		56/12	230	230	175	8.0	0.5	1.0	18	0	7	2	
MAX.	11.0	20.5	3.6		TNC/400	230	230	175	8.5	1.2	1.0	20	0.10			
AVE.	9.36	16.4	1.81			193.95	193.75	136.23	8.05	0.55	0.38	15.8	0.08			
MIN.	7.4	7	0.05		9/0	175	180	80	7.8	0.2	0	12	0			
# SAMPLES	19	19	18			19	8	8	19	19	19	19	19			

DO	Dissolved Oxygen	TH	Total Hardiness	AT	Air Temperature	Weather Code	
WT	Water Temperature	CaH	Calcium Hardness	Wea	Weather	1 -	Sunny
BOD_5	Biochemical Oxygen Demand.	pH	pH	D	Depth	2 -	Cloudy
SEC	Secchi Disc	NO_3	Nitrate Nitrogen			3 -	Precipitation
COL	Total Coliforms	PO_4	Phosphate				
	Faecal Coliforms	SO_4	Sulfate				
ALK	Alkalinity	Fe	Iron				

iii) WATER QUALITY ANALYSIS:

Reservoir Station #1

Although there are three reservoir stations primary emphasis will be placed on Station 1, located approximately 100m upstream of the dam since it was the deepest and revealed a degree of thermal stratification. A comparison between top and bottom waters will be made. At each reservoir station samples were collected weekly nine metre from the surface and one metre from the bottom. Beginning June 14, a Dissolved Oxygen-Water Temperature profile was done every two weeks.

Dissolved Oxygen	Top:	Average 9.7 mg/L	Max. 15.0 mg/L	Min. 7.2 mg/L
	Bottom:	Average 3.5 mg/L	Max. 10.5 mg/L	Min. 0.4 mg/L

See Graph #2 Dissolved Oxygen-Water Temperature Profile

The surface Dissolved Oxygen is certainly acceptable. The greatest differences between top and bottom Dissolved Oxygen occur in early June. Most of the reservoir water is above 5 mg/L. That is to say that during the sampling period Dissolved Oxygen was 5 mg/L or greater to at least 9 m in depth (reservoir depth 16 m). This volume of water increased over the summer gradually (exception Sept. 6) until Sept. 13 when Dissolved Oxygen was 5.0 mg/L at the bottom. As stated earlier, the greatest differences occurred in late spring and early summer. After that point in time Dissolved Oxygen differences varied between 6.0 mg/L and 84 mg/L. This may be due to an increase in Air Temperature which is rapid in June and the resultant establishment of a thermocline. A thermocline is defined as a change of 10°C or greater per metre of depth. A coincidence of Belwood Reservoir is that during the summer of 1977 the 5.0 mg/L Dissolved Oxygen limit followed the same depth profile as the thermocline, virtually from July 12 until dissipation of the thermocline September 13 (Graph #1 Thermocline). An area less than 1.0 mg/L was formed around July 12 and continued through to September 1. It reoccurred on September 6 and quickly dissipated by the following week. As will be pointed out later on, this thermocline did not appear to act as a significant barrier to other parameters mentioned.

Water Temperature

There is not a great difference in temperatures between top and bottom, the maximum difference being 7°C, but there were two distinct water masses for most of the summer. Occasionally a definite thermocline existed, a very shallow zone of transition (see Dissolved Oxygen-Water Temperature profiles) was evident, but at other times although there was an area or volume of water that changed 1°C in one metre, there existed a more gradual change over a few metres. This, in essence, would set up three zones of water, an epilimnion (top water) end metalimnion (the area of gradual temperature change) and a hypolimnion, (an area of definitely cooler water with somewhat less oxygen than existed in the metalimnion and epilimnion). Greatest differences between top and bottom occurred from late May through to July. After that temperature differences were between 1 and 2°C.

Since there is a rapid air temperature change from late May through June and July, it is obvious that the surface waters will warm faster than the bottom, and this occurrence is what initially establishes a thermocline. Because of the shallowness of the reservoir as summer progresses with the resultant wave action, mixing occurs and thermocline dissipates resulting in a homogeneous body of water. This occurred by September 1.

BOD_5 (mg/L)	Average	Maximum	Minimum
Top	1.98	4.60	0.10
Bottom	1.95	4.45	0.05

The summary above shows very little difference between top and bottom, BOD but of interest is that the top water is slightly more enriched than the bottom water. Of 18 times samples were collected the surface BOD was greater on 7 occasions than the bottom. It is expected that bottom waters would have a greater BOD because of the accumulation of organic debris, phosphates and nitrates, It also appears that as the summer progresses the BOD increases so that there is a greater demand in mid to late summer than in the spring or fall. Water temperature has a marked effect since with cooler waters the solubility of Dissolved Oxygen is greater and chemical reaction (or assimilation) is slowed down. For June and July the BOD values for top and bottom indicate a mid-range of organic enrichment (less than 2 mg/L). By the end of July and throughout August the BOD values rise into an area of higher demand (above 3.0 mg/L) indicating increasing organic enrichment.

Secchi Disc

The Secchi Disc is employed to determine the depth of visibility which is a measure of the transparency of the water. The depth of light penetration is affected by light absorption of the water itself or substance dissolved in the water (colour) and the scattering due to turbidity. The enrichment status of lakes can be estimated employing a Secchi Disc and density of chlorophyll ‘a’. As chlorophyll 'a' increases, Secchi Disc depth decreases (the relation is not a direct one). Since chlorophyll 'a' was not measured in this study an indication of density is not made, however, Secchi Disc will be employed to indicate enrichment status.

As an introduction to interpretation of Secchi Disc values some comparative values for other lakes will he given. The Ministry of the Environment has established guidelines based on enrichment status as follows:

Readings between:

0 - 3 m.	enriched
3 - 5 m	moderately enriched
5 and over	unenriched

The Ministry of Natural Resources has established guidelines through their Lake Planning Manual of trophic status based on Secchi Disc readings as follows:

Readings between:

0 - 2 m	eutrophic
2 - 5 m	mesotrophic
5 and over	oligotrophic

The Secchi Disc value used by the Ministry of Natural Resources is basically one of six indices used for a water quality index which is one part of many used in assessing use capacity of lakes.

Secchi Disc readings for various lakes and reservoirs:

Tropical, subtrophic seas, crater lakes	50 metres or more
Clear mountain lakes	20 - 25 m
Lake Tahoe	33 m
Alpine lakes	10 - 15 in
Lowland lakes	from a few decimeters - 10 m
lake Erie	1 - 2.6 m
Lake Ontario	1.8 to > 3.4
Thames Valley	
Wildwood Reservoir	1.1 - 3.2 m
Fanshawe Reservoir	0.46 - 1.5 m
Pittock Reservoir	0.61 - 1.7 m
Guelph Reservoir	2.25 - 4.25 m
Conestogo	0.7 - 2.35 m
Shade's Mill	2.25 - 4.25 m
Laurel Creek	0.35 - 0.75 m
Belwood Reservoir	1.0 - 2.7 m

The average Secchi Disc reading at Belwood is 1.62 m which places its trophic status in the eutrophic stage. Up to the end of June the Secchi Disc values are greater than 2 which implies a mesotrophic status. After that stage surface waters warm, sunlight intensity and duration increase, and the planktonic forms flourish fed by abundant nitrogen and phosphorus and Secchi Disc readings drop.

Total Coliform and Faecal Coliforms

Neither Total nor Faecal Coliforms present a problem at this location.

Faecal Coliforms did exceed once in 19 samples.

Alkalinity, Total Hardness, Calcium Hardness, pH

	TOP			BOTTOM		
	Max.	Ave.	Min.	Max.	Ave.	Min.
Alk mg/L	220	207.2	170	245	190	180
TH mg/L	245	206	200	255	208	200
CaH mg/L	170	147	115	190	147	140
pH	8.6	8.3	7.8	8.5	7.9	7.5

Very little difference exists between top and bottom values for Alkalinity, Total Hardness and Calcium Hardness. Values of Total Hardness and Calcium Hardness are higher here than they are at the inflow. Bottom conditions are slightly more acidic than surface waters but still a basic solution is evident. The accepted range of pH is 6.3 to 8.3. The surface waters reached a maximum of 8.6 on two occasions. If anoxic conditions existed on the bottom the pH would be acidic or less than 7.0.

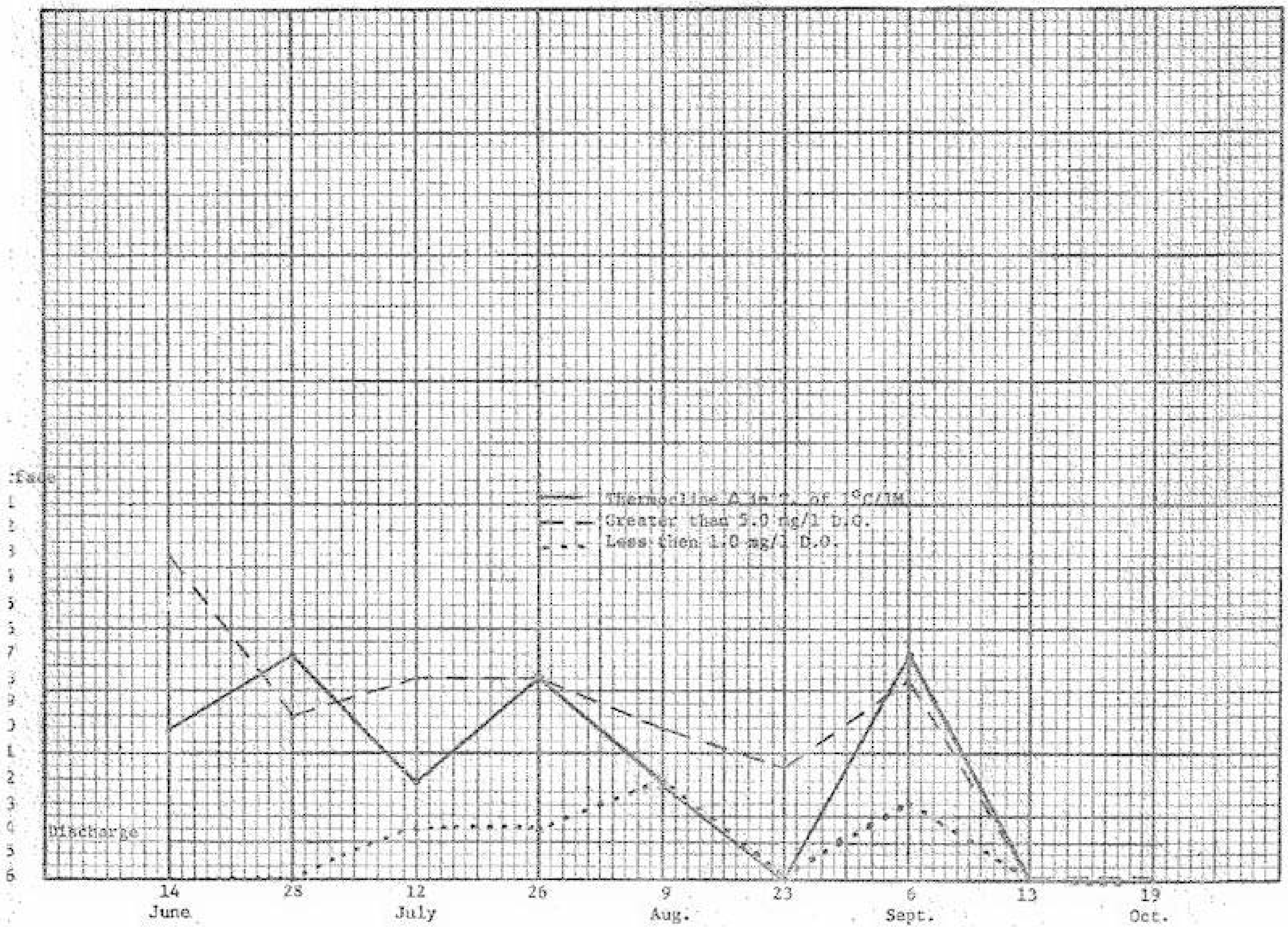
Nitrates and Phosphates

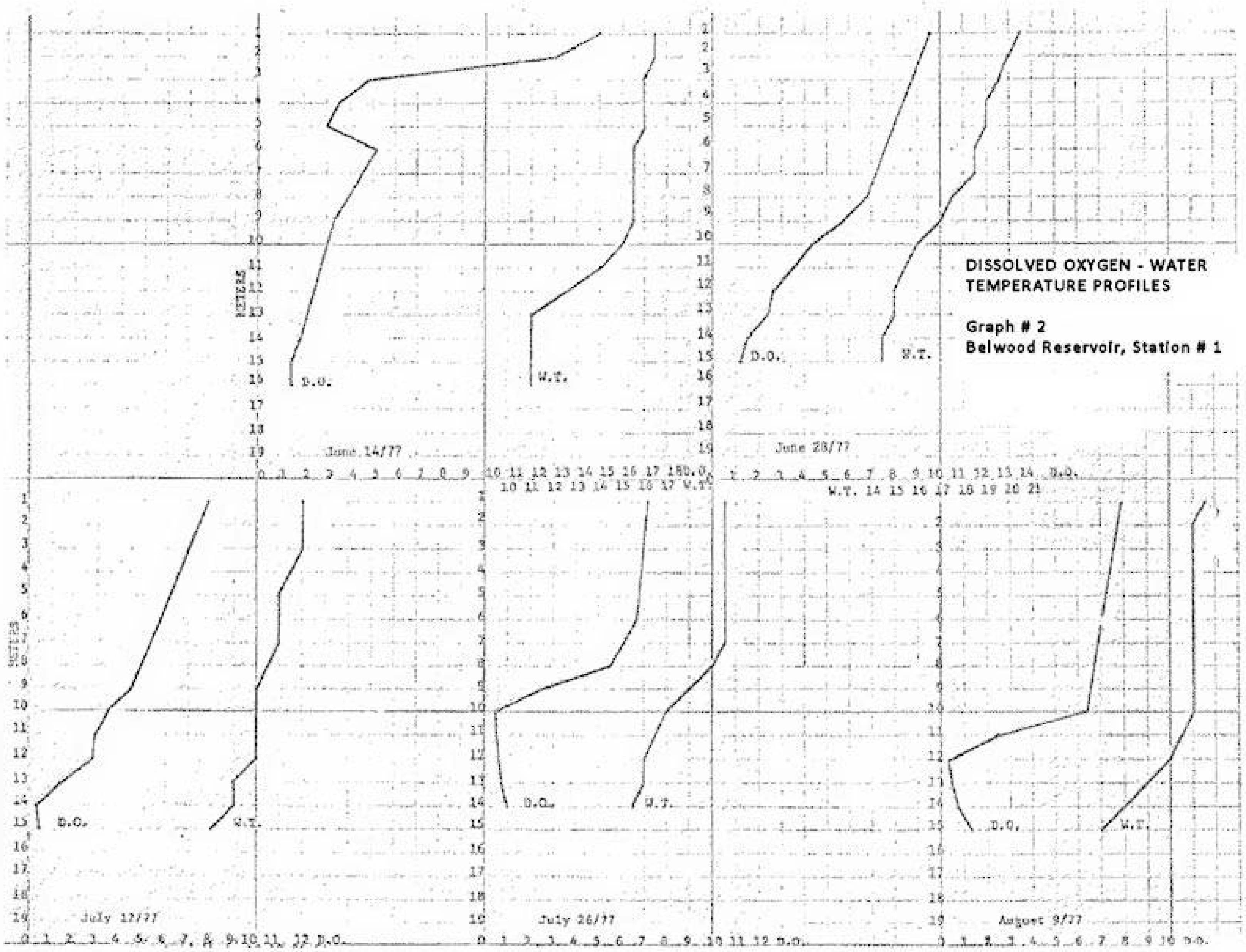
		(mg/L)		
		Max.	Ave.	Min.
Nitrate	- Top	1.1	0.616	0.03
	- Bottom	1.0	0.580	0.20
Phosphate	- Top	1.0	0.313	0.03
	- Bottom	1.0	0.450	0.10

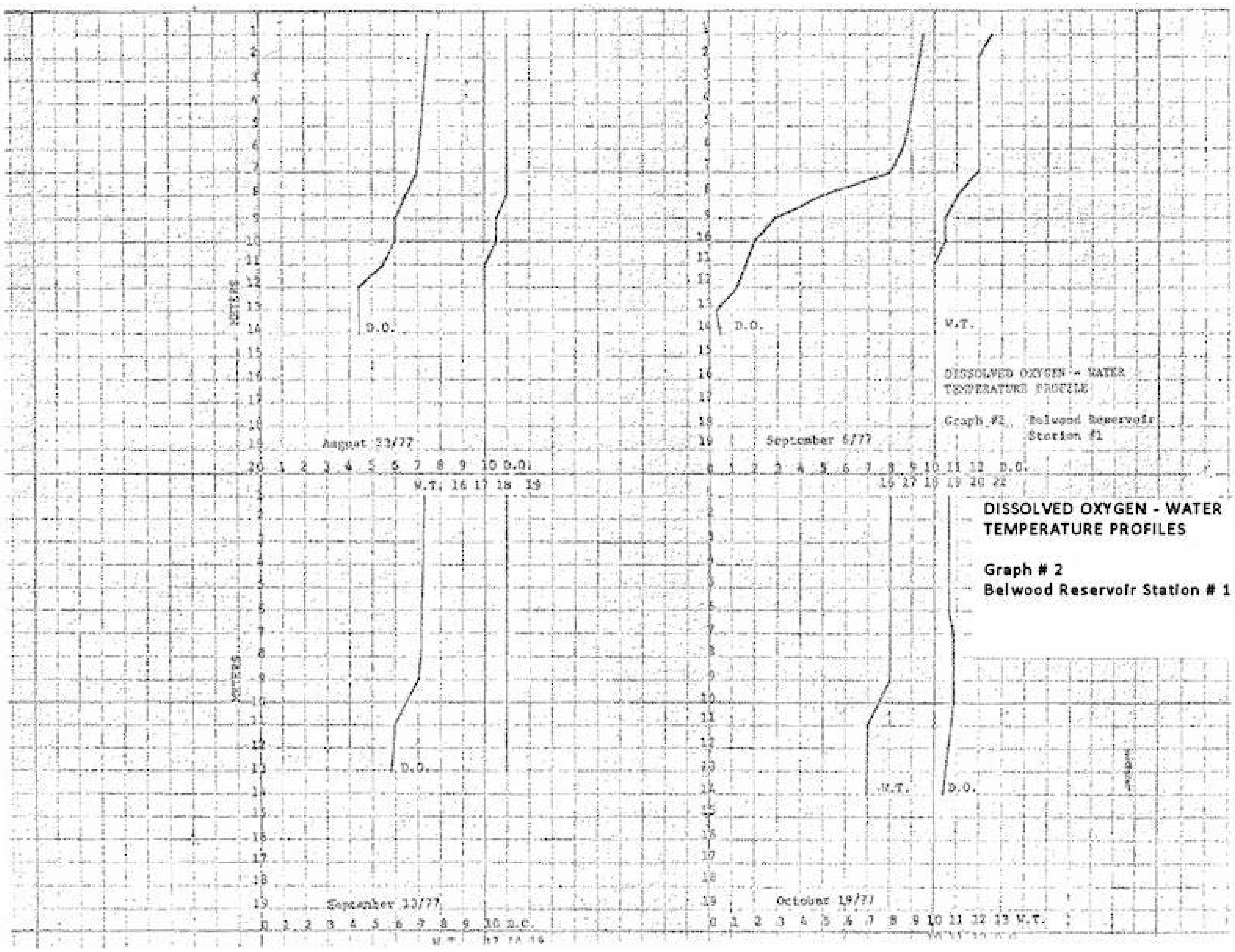
There is a slight difference between top and bottom in both nitrates and phosphates. The surface waters are generally higher in nitrates than the bottom was because of the atmosphere-water interface exchange of nitrogen. The bottom waters are generally higher in phosphates because phosphorus tends to attach to soil particles more readily than nitrogen. There is a buildup of both nitrogen and phosphates on the reservoir bottom based on the fact that the average values for these two parameters is greater than what is leaving. As was pointed out earlier, the outflow is discharging more phosphates and nitrates than are entering the reservoir. This leads to the conclusion that there is a source within the reservoir contributing these two nutrients. The bottom water indicates the highest value recorded (with the exception of station #2) of all measured points. Obviously there is sufficient nutrient available in the water column to allow abundant planktonic growth. It is also suggested that the present use of Belwood Reservoir (cottages, mobile homes, campgrounds, etc.) are contributing nutrients to the reservoir through fertilization, septic systems and conceivably, dish water wastes which results in increased. nutrient levels discharged downstream.

Sulfates and Iron

Both parameters fall within the acceptable range. There is very little difference between top and bottom sulfate values. The bottom values of iron are greater than the surface values.


Greater than 5.0 mg/l D.O.
Less then 1.0 mg/l D.O.
Discharge
14
June
28
12
July
26
9
Aug.
23
6
Sept.
13
19
Oct.


DISSOLVED OXYGEN - WATER TEMPERATURE PROFILES
Graph # 2
Belwood Reservoir, Station # 1
June 14/77
June 28/77
July 12/77
July 26/77
August 9/77
D.O.
W.T.
METERS



DISSOLVED OXYGEN - WATER TEMPERATURE PROFILES

Graph # 2
Belwood Reservoir Station # 1

AREA : BELWOOD LAKE STATION: #1 DEPTH: TOP

DATE 1977	DO	WT	BOD	SEC	COL T/F	ALK	TH	CaH	pH	NO_3	PO_4	SO_4	Fe	AT °C	Wea	D (m)
May 17	11.9	13.5	0.85	1.80	3/0	180	200	150	7.9	1.1	0.11	16	0.05	31	1	1
May 24	11.8	18	1.625	2.0	4/0	460	200	145	8.5	1.0	0.10	18	0.05	24	1	1
May 31	13.0	18		2.7	10/0	190	200	140	8.2	1.1	0.05	15	0	21	1	1
June 7	13.3	16	0.6	2.65	230/0	185	200	145	8.4	1.0	0.03	14	0	8	2	
June 14	15.0	16.5	1.9	2.25	116/0	185			8.2	0.5	0.06	16	0.10	18	2	
June 21	8.9	18	1.65	1.30	14/0	200			8.2	1.2	0.08	18	0.05	17	1	
June 28	9.6	20.5	1.05	2.0	28/4	195			8.6	0.4	0.08	13	0.15	25	1	
July 5	8.7	20.5	1.9	1.75	20/0	190	205	140	8.5	0.6	0.10	16	0.10	24	2	
July 12	7.8	20	0.95	1.65	28/0	190			8.5	0.5	0.09	16	0	23	2	
July 19	9.0	23	1.75	1.35	0/0	190			8.4	0.3	0.20	11	0	26	2	
July 26	7.2	21.5	2.0	1.0	20/0	190			8.5	0.5	0.40	14	0	17	2	
Aug. 4	8.0	21	3.45	1.30	4/4	180			7.8	0.4	0.15	15	0	21	2	
Aug. 9	7.8	21.5	1.65	1.55	26/16	175	200	135	8.5	0.5	0.35	13	0.09	19	2	
Aug16	7.8	20.5	2.35	1.30	20/10	185			8.4	0.3	0.28	15	0	16	2	
Aug. 23	7.5	18	2.65	1.40	240/16	170			7.8	0.4	0.53	13	0	17	2	
Avg. 30	8.3	19	3.75	1.40	60/12	175			8.1	0.3	0.60	18		17	2	
Sept. 6	9.5	20.5	4.6	1.25	34/6	170			8.6	0.5	0.85	20	0.10	18	2	
Sept. 13	7.3	18.0	2.7	1.10	188/140	180	195	150	8.2	0.4	0.80	17	0	15	3	
Oct. 19	10.7	6.0	0.1	1.0	8/14	220	245	170	7.9	0.7	1.0	18	0.10	7	1	
MAX.	15.0	21.5	4.60	2.7	230/140	220	245	170	8.6	1.1	1.0	20.0	0.15			
AVE.	9.65	16.6	1.98	1.62		207.2	205.6	146.9	8.27	0.616	0.313	14.9	0.036			
MIN.	7.2	8.0	0.1	1.0	0/0	170	200	135	7.8	0.03	0.03	11.0	0			
#	19	19	18	19	19	19	8	8	19	19	19	19	19			

DO	Dissolved Oxygen	TH	Total Hardiness	AT	Air Temperature	Weather Code	
WT	Water Temperature	CaH	Calcium Hardness	Wea	Weather	1 -	Sunny
BOD_5	Biochemical Oxygen Demand.	pH	pH	D	Depth	2 -	Cloudy
SEC	Secchi Disc	NO_3	Nitrate Nitrogen			3 -	Precipitation
COL	Total Coliforms	PO_4	Phosphate				
	Faecal Coliforms	SO_4	Sulfate				
ALK	Alkalinity	Fe	Iron				

AREA: BELWOOD LAKE STATION: #1 DEPTH: BOTTOM

DATE 1977	DO	WT	BOD	SEC	COL T/F	ALK	TH	CaH	pH	NO_3	PO_4	SO_4	Fe	AT °C	Wea	D (m)
May 17	8.5	11.5	0.95	1.80	1/0	200	200	150	7.5	1.0	0.10	16	0.09	31	1	17.5
May 24	7.8	12.0	0.90	2.0	0/0	180	200	145	8.2	0.25	0.15	20	0.05	24	1	17.25
May 31	3.4	11.0		2.70	1/0	190	200	150	7.6	0.9	0.35	15	0.15	21	1	17
June 7	5.0	10.0	0.70	2.65	88/0	195	200	145	8.0	2.0	0.25	18	0.10	8	2	17
June 14	1.5	11.0	1.65	2.25		190			7.5	0.2	0.20	19	0.20	18	2	17
June 21	1.5	13.0	1.65	1.30		190			8.0	0.4	0.18	13	0.05	17	1	16
June 28	1.2	14.5	2.70	2.0		215			8.2	0.4	0.17	11	0.10	25	1	16.25
July 5	1.2	16.5	0.75	1.75		200	200	150	8.0	0.5	0.17	14	0.12	24	2	16
July 12	0.5	16.0	1.75	1.65		210			7.7	0.4	0.21	16	0.21	23	2	16
July 19	0.7	18.0	2.30	1.35		200			8.0	0.5	0.50	12	0.15	26	2	15.5
July 26	1.0	17.5	4.45	1.0		210			7.6	0.4	0.40	14	0.20	17	2	15
Aug. 4	1.5	19.5	2.20	1.3		190			8.5	0.4	0.35	15	0.10	21	2	14.25
Aug. 9	1.3	17	3.05	1.55		200	210	145	7.8	0.4	0.60	13	0.32	19	2	15.5
Aug. 16	5.5	20	1.55	1.30		190			8.1	0.5	0.30	14	0.10	16	2	14.5
Aug. 23	4.5	17	1.65	1.40		150			7.6	0.7	0.85	24	0.15	17	2	15
Aug. 30	4.4	17	3.15	1.40		190			7.7	0.4	0.90	21	0.15	17	2	15
Sept. 6	0.4	18	3.15	1.25		180			7.8	0.4	1.10	17	0.15	18	2	14.5
Sept.13	5.8	18	2.95	1.10		185	200	140	7.8	0.6	0.90	19	0.20	15	3	14
Oct. 19	10.4	7.0	0.05	1.0		245	255	150	7.8	0.6	0.90	21	0.10	7	1	14
MAX..	10.4	20.0	4.45			245	255	150	8.5	1.0	1.1	24	0.32			
AVE.	3.48	15.0	1.975			190	208	146.8	7.86	0.58	0.45	16.3	0.142			
MIN.	0.4	7.0	0.05			180	200	140	7.5	0.2	0.1	11	0.09			
# SAMPLES	19	19	18	19		19	8	8	19	19	19	19	19			

DO	Dissolved Oxygen	TH	Total Hardiness	AT	Air Temperature	Weather Code	
WT	Water Temperature	CaH	Calcium Hardness	Wea	Weather	1 -	Sunny
BOD_5	Biochemical Oxygen Demand.	pH	pH	D	Depth	2 -	Cloudy
SEC	Secchi Disc	NO_3	Nitrate Nitrogen			3 -	Precipitation
COL	Total Coliforms	PO_4	Phosphate				
	Faecal Coliforms	SO_4	Sulfate				
ALK	Alkalinity	Fe	Iron				

iv) WATER QUALITY ANALYSIS:

Reservoir Station #2

Very little difference in surface waters between Station 1 and 2 are evident. The Dissolved Oxygen at Station 2 is certainly satisfactory with a minimum of 6.7 mg/L being recorded. On four of the nineteen times samples were collected the bottom water Dissolved Oxygen was the same or greater than the surface Dissolved Oxygen. A slight stratification was apparent through June but dissipated after that date with only a slight variation in top and bottom water temperatures. Water depth in May was 10 metres and dropped to minimum of 4.5 by mid-August. (See Graph #3).

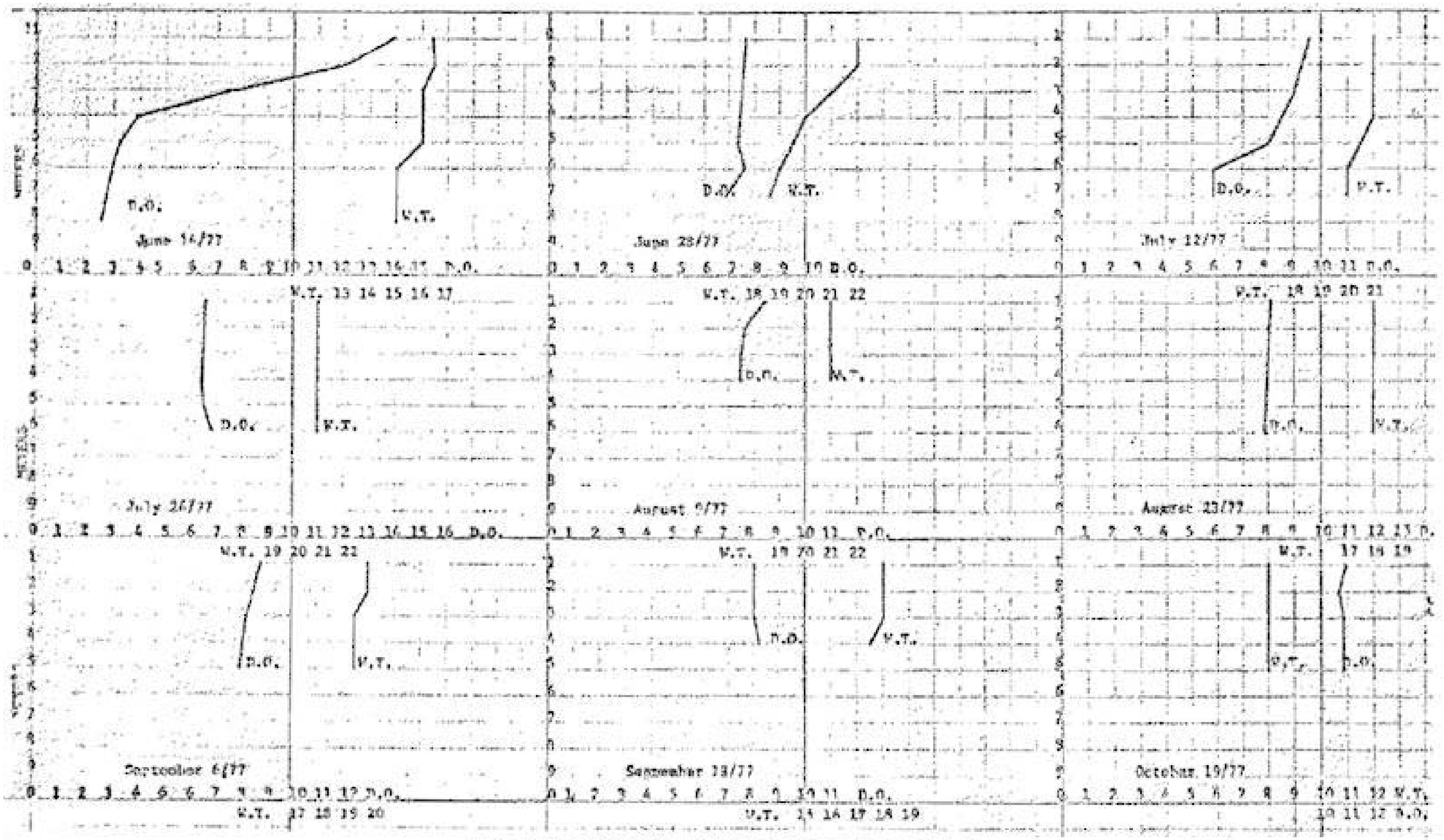
The BOD exhibited poorer conditions here than at Station 1. The surface water BOD was definitely worse than the bottom water. From May to July 5 the BOD exceeded 2.0 mg/L on 3 to 6 occasions, after that date to October 19, 2.0 mg/L BOD was surpassed 11 of 12 times collected. Obviously the surface waters at this location are fairly enriched. The Secchi Disc values show a maximum of 2.70 metres, a minimum of 1.0 metre and an average over the summer of 1.52 metres. These values are very similar to those recorded at Station 1. The trophic status implied is mesotrophic-eutrophic.

Total and Faecal Coliforms varied erratically throughout the summer, neither of the two ever exceeding established criteria. Alkalinity, Total Hardness, Calcium Hardness and pH are similar to Station 1 and indicate again that the lake has excellent buffering capacity, the water is very hard and the solution is alkaline tending to be at the higher end of the pH criterion scale (6.5 - 8.3).

Nitrates and Phosphates

Nitrates values are very similar to inflowing waters. The bottom water nitrate values are slightly higher than those recorded at the top. The nitrate values are in the range to provide adequate nutrients to feed and promote the growth of plankton. There is an increase in phosphorus concentration throughout the reservoir with station #2 revealing the highest value. As the water flows from the inflow through reservoir stations to the outflow the average illustrates a general increase. There also seems to be a significant increase in bottom values from approximately July 12 to the end of the sampling period.

Sulfates and iron fall within accepted ranges and present no problems to Belwood Reservoir.



DISSOLVED OXYGEN - WATER TEMPERATURE PROFILES
Graph # 3 - Belwood Reservoir, Station # 3

AREA: BELWOOD LAKE STATION: #2 DEPTH: TOP

DATE 1977	DO	WT	BOD	SEC	COL T/F	ALK	TH	CaH	pH	NO_3	PO_4	SO_4	Fe	AT °C	Wea	D (m)
May 17	12.3	14.5	2.3	1.80	0/0	175	200	150	8.2	0.80	0.27	16	0	27	1	1
May 24	12.0	20	1.3	2.20	0/0	230	200	140	8.3	0.75	0.20	17.5	0	27	1	
May 31	13.2	18		2.70	4/0	190	200	145	8.2	1.0	0.10	15	0.05	26	1	
June 7	11.6	16	2.1	2.5	300/2	190	200	135	8.5	1.5	0.38	15	0.10	9	2	
June 14	13.8	16.5	1.2	2.4	132/2	195			8.4	0.4	0.18	18	0	20	2	
June 21	8.7	18	2.1	1.7	4/6	200			8.8	0.2	0.10	13	0	18	1	
June 28	7.6	20	1.15	1.7	16/4	200			8.8	0.5	0.18	13	0	26	1	
July 5	8.8	21	2.4	1.65	50/0	195	190	135	8.4	0.4	0.20	13	0	24	2	
Jay 12	9.5	21	2.1	1.45	2/0	190			8.5	0.75	0.12	16	0.10	23	2	
July 19	9.2	24	2.9	1.2	0/0	190			8.9	0.3	0.30	13	0	26	2	
July 26	6.7	21	3.3	1.0	10/4	185			8.5	0.5	0.45	15	0.10	17	2	
Aug. 4	8.8	21.5	4.65	1.0	0/8	170			8.5	0.4	0.15	17	0.11	21	2	
Aug. 9	8.4	21	3.35	0.85	8/32	170	210	135	8.6	0.2	0.31	16	0.01	19	2	
Aug. 16	8.2	20	2.9	1.30	550/14	180			7.8	0.3	0.32	15	0.05	16	3	
Aug. 23	8.1	18	4.25	1.0	66/10	175			7.8	0.3	0.42	16	0.05	18	2	
Aug. 30	9.0	19.5	4.3	1.25	50/2	175			8.1	0.3	0.60	19	0	17	2	
Aug. 6	8.8	20.0	3.45	1.20	80/2	175			8.6	0.5	0.65	19	0	19	2	
Sept 13	8.0	18.0	3.65	1.0	320/2	175	190	140	8.6	0.5	0.50	18	0.05	15	3	
Oct. 19	10.8	8.0	0.3	1.0	8/8	225	255	180	8.4	1.0	1.10	24	0.15	7	1	
MAX.	13.8	21.5	4.65	2.70	550/14	230	255	180	8.9	1.0	1.10	24	0.14			
AVG.	9.66	18.7	2.65	1.52		188.7	201.8	145	8.42	0.56	0.35	16.2	0.09			
MIN.	6.7	8	0.3	1.0	0/0	170	190	135	7.8	0.20	0.10	13	0			
# SAMPLES	19	19	18	19	19	19	8	8	19	19	19	19	19			

DO Dissolved Oxygen
WT Water Temperature
BOD_5 Biochemical Oxygen Demand.
SEC Secchi Disc
COL Total Coliforms
Faecal Coliforms
ALK Alkalinity

TH Total Hardiness
CaH Calcium Hardness
pH pH
NO_3 Nitrate Nitrogen
PO_4 Phosphate
SO_4 Sulfate
Fe Iron

AT Air Temperature
Wea Weather
D Depth

Weather Code
1 - Sunny
2 - Cloudy
3 - Precipitation

AREA: BELWOOD LAKE STATION : # 2 DEPTH : BOTTOM

DATE 1977	DO	WT	BOD	SEC	COL T/F	ALK	TH	CaH	pH	NO_3	PO_4	SO_4	Fe	AT °C	Wea	D (m)
May 17	9.6	11.0	0.35	1.80	0/0	180	210	150	7.9	1.2	0.12	18	0·01	27	1	10
May 24	7.5	13.0	0.525	2.20	010	270	200	140	8.1	0.3	0.15	18	0.03	27	1	9.75
May 31	6.2	12.0		2.7	9/0	190	200	240	8.2	0.8	0.10	15	0.02	26	1	9.50
June 7	3.5	15	1.4	2.5	370/2	190	200	140	8.4	1.3	0.08	18	0.08	9	2	9.75
June 14	2.5	12	1.5	2.4		195			8.1	0.5	0.11	16	0.05	20	2	8.75
June 21	7·7	16	1.2	1.7		200			8.0	0.8	0.06	17	0.10	18	1	8.5
June 28	6.9	18.5	2.2	1.7		195			8.3	0.5	0.08	13	0.05	26	1	8.25
July 5	6.8	19	1.05	1.65		195	195	140	8.4	0.5	0.08	12	0	24	2	8.5
July 12	6.9	20	0.70	1.45		205			8.5	0.75	0.10	18	0.18	23	2	8.0
July 19	4.6	21	0.95	1.20		190			8.3	0.6	0.50	14	0.05	26	2	7.0
July 26	6.8	21	2.8	1.0		185			8.4	0.5	0.50	15	0.10	17	2	6.75
Aug. 4	8.3	21.5	3.85	1.0		180			8.4	0.4	0.12	15	0.09	21	2	5.25
Aug. 9	7.4	21	1.7	0.85		175	210	135	8.5	0.4	0.31	14	0.09	19	2	5.0
Aug. 16	3.6	19.5	3.45	1.30		180			8.5	0.4	0.25	15	0	16	3	4.5
Aug. 23	7.9	18	3.05	1.0		175			7.5	0.3	0.42	14	0	18	2	6.75
Aug. 30	9.0	19	4.7	1.25		175			8.2	0.4	0.70	19	0	17	2	5.5
Sept. 6	8.1	19.5	3.65	1.20		165			8.2	0.25	0.85	17	0	19	2	5.0
Sept. 13	8.1	17.5	3.95	1.0		180	195	165	8.2	0.6	0.70	19	0	15	3	5.25
Oct. 19	10.8	8.0	0.55	1.0		220	200	180	8.4	0.8	1.10	21	0.20	7	1	5.5
MAX.	10.8	21.5	4.7			270	210	150	8.6	1.3	1.3	21	0.2			
AVE.	7.22	18.2	2.09			191.8	201.25	148.75	8.25	0.59	0.33	16.2	0.05			
MIN.	2.5	8	0.35			165	195	135	7.5	0.3	0.06	12	0			
# SAMPLES	19	19	18			19	8	8	19	19	19	19	19			

DO	Dissolved Oxygen	TH	Total Hardiness	AT	Air Temperature	Weather Code	
WT	Water Temperature	CaH	Calcium Hardness	Wea	Weather	1 -	Sunny
BOD_5	Biochemical Oxygen Demand.	pH	pH	D	Depth	2 -	Cloudy
SEC	Secchi Disc	NO_3	Nitrate Nitrogen			3 -	Precipitation
COL	Total Coliforms	PO_4	Phosphate				
	Faecal Coliforms	SO_4	Sulfate				
ALK	Alkalinity	Fe	Iron				

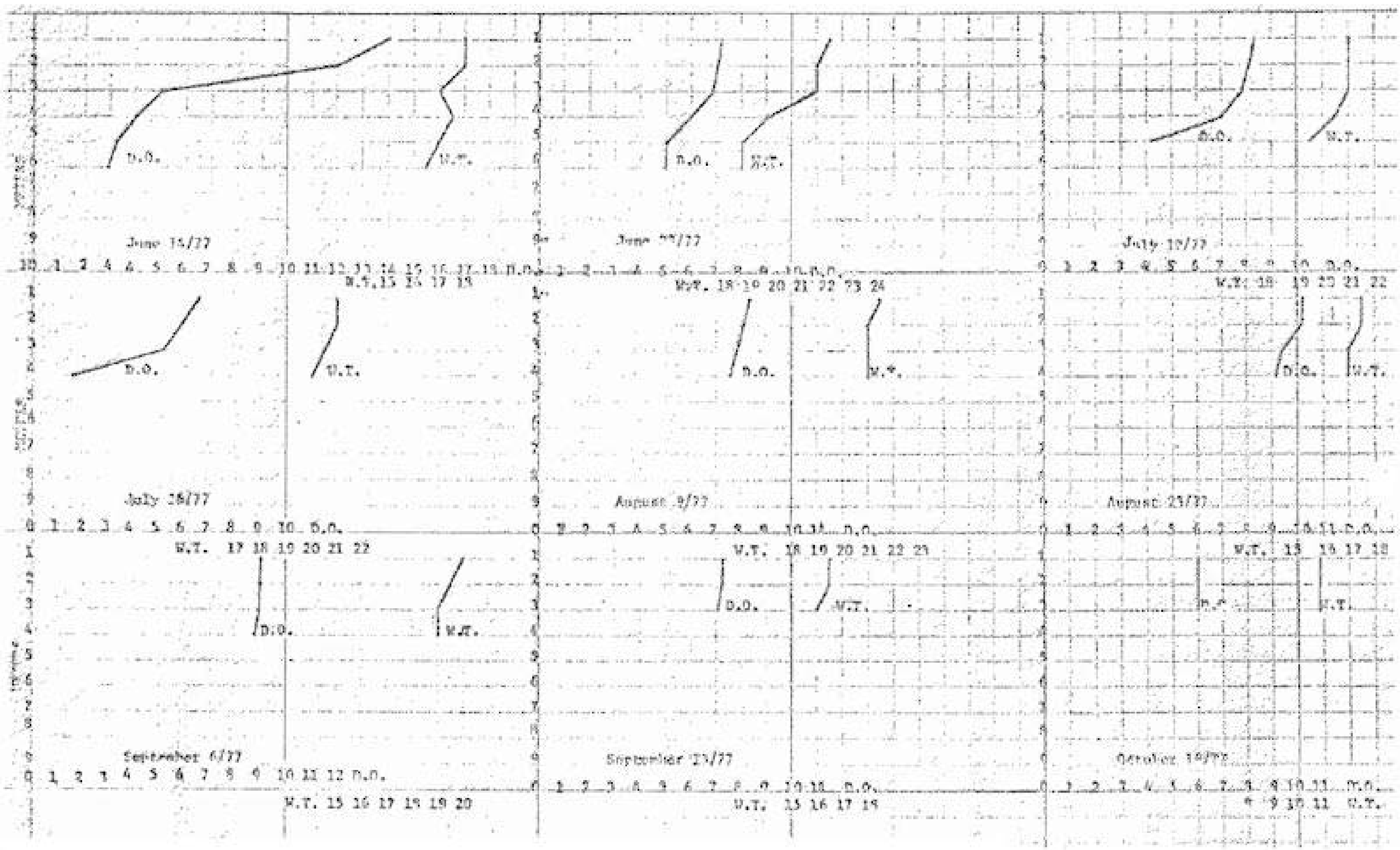
v) WATER QUALITY ANALYSIS:

Reservoir Station #3

This location may be referred to “the transition zone"; an area that has changed the watercourse from a dynamic flowing situation to a static, slowly flowing situation.

The depth of water varied from a maximum of 7.25 metres in late May to 3.5 metres by October 19. In spite of this relatively shallow depth a noticeable temperature change was evident up to the end of June Initially the inflowing Water Temperature was warmer than the reservoir but by June and throughout the summer the inflow was cooler by 1 to 3 degrees. It is obvious then that one of the first affects of the reservoir is to increase the water temperature. There is a great difference between top and bottom water Dissolved Oxygen and a slight increase in Dissolved Oxygen of the surface waters in comparison to the inflow. The surface Dissolved Oxygen also had a greater range and fell below 7 mg/L only once in 19 collections. As is the case of the other two reservoir stations the greatest difference in Dissolved Oxygen between top and bottom occurs in late Spring, early Summer with the exception of 2-3 occasions, Dissolved Oxygen of the bottom waters did not fall below 4.0 mg/L during the sampling period. (Graph #4).

Reservoir stations #1 and #2 indicated slightly more surface oxygen demand than the bottom water. This also the case for station #3 but to a greater degree. Top water BOD exceeds 2.0 mg/L 13 of 18 times samples were measured. The poorest period started around July 5. From this period on, BOD exceeds 3.0 mg/L 10 of 12 times. These values indicate a fairly high level of organic enrichment. What is surprising is that the bottom waters have an average BOD of 1.97 mg/L, only mildly enriched. A partial explanation for higher BOD can be offered for the surface waters but not for the lower reading on the bottom. Station 3 is located under the bridge that leads to the village of Belwood. It is also the main channel of boating activity and there is a boat launch area several 100 yards away. By confining a lot of activity to this area more agitation and enrichment is caused, and there may be significant contamination from road runoff. These factors, but primarily high activity contribute to a high oxygen demand.



DISSOLVED OXYGEN - WATER TEMPERATURE PROFILES

Graph # 4 - Belwood Reservoir, Station # 3

Station 3 also provides the lowest visibility of all reservoir stations being 2.3 metres, 1.38 metres, and 0.6 metres for maximum, average and minimum respectively. The same factors that contribute to high surface BOD's apply here to reduce the clarity of the water. Total and Faecal Coliforms do not pose a problem at this location. Sulfates and iron are in the same category, that is posing no problem.

There is a slight increase in nitrates over the inflowing values. Again the nature of the concentration will allow aquatic plant growth. The surface levels are greater than the bottom levels. Phosphates on the other hand are very similar to those recorded at the inflow, with bottom values being slightly higher than both the surface and the inflow.

AREA: BELWOOD LAKE STATION: # 3 DEPTH: TOP

DATE 1977	DO	WT	BOD	SEC	COL T/F	ALK	TH	CaH	pH	NO_3	PO_4	SO_4	Fe	AT °C	Wea	D (m)
May 17	11.8	16.0	3.05	1.65	0/0	190	210	150	8.4	0.98	0.10	17.5	0.03	29	1	1
May 24	12.2	21.5	2.35	1.90	0/0	370	200	150	8.4	1.05	0.19	19.0	0.05	28	1	
May 31	12.0	17.5		2.30	5/0	190	200	140	8.0	1.1	0.13	17	0	23	1	1
June 7	12.0	14	1.9	2.0	175/0	185	210	145	8.4	1.8	0.02	15	0	9	2	
June 14	14.0	17	0.7	2.4	TNC/4	190			8.2	0.4	0.12	17	0	20	2	
June 21	9.2	15	3.1	1.2	16/2	190			8.7	0.4	0	15	0	19	1	
June 28	7.2	22.5	1.6	1.75	66/2	200			8.6	0.6	0.05	17	0.05	27	1	
July 5	9.3	23	4.2	1.0	0/0	190	185	140	8.4	0.3	0	13	0	25	2	
July 12	8.3	21	1.9	1.4	14/6	190			8.4	0.5	0.03	16	0.02	23	2	
July 19	8.5	25	4.75	0.90	2/0	180			8.7	0.2	0.40	15	0.19	26	2	
July 26	6.4	21	5.3	0.80	12/0	185			8.1	0.4	0.40	14	0.15	17	2	
Aug. 4	7.4	22	4.53	0.75	2/0	155			8.4	0.4	0.20	14	0.08	21	2	
Aug. 9	8.3	21.5	3.75	0.85	30/132	150	165	110	8.5	0.2	0.41	14	0.03	19	2	
Aug. 16	8.5	20	3.25	1.0	2/20	155			8.6	0.6	0.32	16	0.10	16	3	
Aug. 23	10.2	17.5	7.4	0.6	16/4	170			7.8	0.2	0.52	21	0	18	2	
Aug. 30	8.0	21	3.5	1.0	36/18	175			8.2	0.3	0.50	24	0.10	17	2	
Sept. 6	9 0	20	2.4	1.35	66/36	200			8.1	0.4	0.70	21	0.05	19	2	
Sept 13	9.2	6.5	3.4	1.0	280/8	185	190	145	8.3	0.5	0.50	18	0.05	15	3	
Oct. 19	10.8	6.0	0	2.30	30/20	260	245	210	8.0	0.8	0.55	20	0.10	7	1	
MAX.	14.0	25.0	5.3	2.30	TNC/112	370	245	150	8.7	1.35	0.7	24	0.19			
AVE.	9.03	19.05	3.36	1.38		195.3	200.6	148.8	8.33	0.6	0.27	16.8	0.05			
MIN.	6.4	6.0	0.07	0.6		150	165	110	7.8	0.2	0	12	0			
#SAMPLES	18	19	17	19	19	19	.8	8	19	19	19	19	19			

DO Dissolved Oxygen
WT Water Temperature
BOD_5 Biochemical Oxygen Demand.
SEC Secchi Disc
COL Total Coliforms
Faecal Coliforms
ALK Alkalinity

TH Total Hardiness
CaH Calcium Hardness
pH pH
NO_3 Nitrate Nitrogen
PO_4 Phosphate
SO_4 Sulfate
Fe Iron

AT Air Temperature
Wea Weather
D Depth

Weather Code
1 - Sunny
2 - Cloudy
3 - Precipitation

AREA : BELWOOD LAKE STATION: #3 DEPTH: BOTTOM

DATE 1977	DO	WT	BOD	SEC	COL T/F	ALK	TH	CaH	pH	NO_3	PO_4	SO_4	Fe	AT °C	Wea	D (m)
May 17	9.0	11.5	0.75	1.65	4/0	185	210	150	7.9	0.9	0.10	15	0.05	29	1	7.25
May 24	9.0	15.0	1.2	3.90	6/0	275	200	145	7.2	0.75	0.14	19.5	0.04	23	1	7.25
May 31	9.2	16.0		2.30	49/1	185	200	140	8.2	0.9	0.15	12	0	23	1	7.0
June 7	3.2	13.0	1.8	2.0	250/0	185	190	140	8.0	1.0	0.15	16	0	9	2	6.5
June 14	2.9	15.5	2.2	2.4		190			8.1	0.4	0.13	14	0.2	20	2	6.5
June 21	7.3	17.5	1.25	1.2		195			8.4	0.4	0.13	14	0	19	1	6.25
June 28	4.9	19	1.3	1.75		200			8.4	0.5	0.14	12	0.05	27	1	6.0
July 5	6.9	20	1.55	1.0		195	180	130	7.6	0.6	0.18	15	0.1	25	2	5.8
July 12	4.2	19.5	1.25	1.4		180			7.7	0.4	0.12	16	0.1	23	2	5.5
July 19	2.3	22.5	1.65	0.9		185			8.2	0.4	0.30	15	0.2	16	2	5.25
July 26	1.5	20	3.9	0.8		195			7.6	0.3	0.30	11	0.05	17	2	4.5
Aug 4	4.55	21	3.75	0.75		155			8.5	0.4	0.28	15	0.18	21	2	4.25
Aug. 9	7.5	21	1.60	0.85		140	175	110	8.2	0.3	0.40	14	0.1	I9	2	4.25
Aug. 16	8.0	18.5	2.45	1.0		155			8.4	0.4	0.25	14	0.1	16	3	4.0
Aug. 23	9.2	17	4.0	0.6		180			7.8	0.4	0.80	29	0.1	18	2	4.75
Aug. 30	7.6	20	3.8	1.0		180			8.2	0.4	0.10	17	0.15	17	2	4.5
Sept 6	6.7	19	1.6	1.35		215			8.3	0.5	0.90	24	0.1	19	2	4.0
Sept.13	9.1	16	2.2	1.0		190	200	140	8.0	0.4	0.40	17	0.05	15	3	3.5
Oct. 19	10.8	6	0.25	2.30		160	255	215	8.4	0.3	0.55	18	0.15	7	1	1.5
MAX.	10.8	22.5	4.00			275	255	215	8.5	1.0	0.9	29	0.18			
AVE.	6.4	18.3	1.97			191.8	178.8	146.3	8.05	0.54	0.33	15.13	0.09			
MIN.	1.5	6	0.25			155	175	110	7.2	0.3	0.1	11	0			
# SAMPLES	19	19	18			19	8	8	19	19	19	19	19			

DO Dissolved Oxygen
WT Water Temperature
BOD_5 Biochemical Oxygen Demand.
SEC Secchi Disc
COL Total Coliforms
Faecal Coliforms
ALK Alkalinity

TH Total Hardiness
CaH Calcium Hardness
pH pH
NO_3 Nitrate Nitrogen
PO_4 Phosphate
SO_4 Sulfate
Fe Iron

AT Air Temperature
Wea Weather
D Depth

Weather Code
1 - Sunny
2 - Cloudy
3 - Precipitation