DETERMINATION OF SOME BACTERIOLOGICAL POLLUTION PARAMETERS AT BÜYÜKÇEKMECE LAKE

by

Abdullah KIRAN

Submitted to the Graduate Studies Institute of Sciences and Engineering
in partial fulfilment of the requirements for the degree of
Master of Science
in
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Fen Bilimleri Enstitüsü Müdürlüğü'ne

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DETERMINATION OF SOME BACTERIOLOGICAL POLLUTION PARAMETERS AT BÜYÜKÇEKMECE LAKE

Abdullah KIRAN

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KEYWORDS: Büyükçekmece lake bacterial pollution, BOD_5, COD, Total and Fecal Coliform.

ABSTRACT

This study covers investigations made on the bacterial pollution of Büyükçekmece lake, which supplies 16 % of İstanbul's drinking water. The data was collected at four stations, namely; Bahsayiş, Çakıldere, Tepecik, and Mezarlıkönü between January and December 1999 and compared periodically with standards.

The parameters like temperature, pH, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total and fecal coliform were measured.

The results obtained showed that, pH and temperature were within the range of standards. On the other hand biochemical oxygen demand (BOD) and chemical oxygen demand (COD) varied according to the sampling sites and seasons. When the quality of lake water is evaluated in relation to these parameters, it generally fits with the criteria of secondary quality water but, sometimes it shows values agreeing with primary quality however; sometimes it drops down below limits of even secondary class. Many differences were observed in the total and fecal coliform values. Fecal

coliforms could not be encountered in some months, but there was a considerable increase at 3 stations in February. Generally an increase was observed in the amounts of total coliforms, during summer months which showed a parallelism in all stations. There are several factors that affect the increase in total and fecal coliform to a certain degree. One of these is the domestic wastes discharged into the brooks without any treatment. The other is that some residential areas are very close to the lake.

When the results are compared with standards, we find some differences in the samples taken from different stations, depending on the seasonal conditions. These differences give clues about microbial pollution. We can infer that these differences are related to the changes in the amount of organic substances present in the lake and the seasonal factors.

A comparison between the results of four stations fully enlightens us about the sources of pollution. According to these results, Büyükçekmece lake is being polluted by effluent entering the lake through the brooks flowing into the lake without any treatment. These polluting sources are the sewerage and domestic wastes of Tepecik, Çatalca, and surround villages.

BÜYÜKÇEKMECE GÖLÜNDE BAZI BAKTERİYOLOJİK KİRLİLİK PARAMETRELERİNİN ARAŞTIRILMASI

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ANAHTAR KELİMELER: Büyükçekmece gölü bakteriyal kirliliği, BOI_5, KOI, Total ve Fekal Koliform.

ÖZET

Bu çalışmada İstanbul'un içme ve kullanma suyu ihtiyacının % 16'sını karşılayan Büyükçekmece gölü 1999 yılı Ocak ve Aralık ayları arasında her ay periyodik olarak incelenerek bakteriyal kirliliğin boyutları standartlara göre karşılaştırılmıştır.

Belirlenen dört istasyondan alınan örneklerde bazı parametreler ölçülmüştür. Bu parametreler sıcaklık, pH, biyokimyasal oksijen ihtiyacı (BOI), kimyasal oksijen ihtiyacı (KOI), total ve fekal koliform'dur.

Elde ettiğimiz bulgulardan pH ve sıcaklık değerlerinin standartlara uygun olduğu gözlenmiştir. Biyokimyasal oksijen ihtiyacı (BOI) ve kimyasal oksijen ihtiyacı (KOI) değerleri ise mevsimlere ve örnekleme noktalarına göre farklılık göstermiştir.Bu parametrelerce göl suyunun kalitesi değerlendirildiğinde genel olarak ikinci kalite su kriterlerine uymasına rağmen bazen birinci dereceye uygunluk göstermiş bazende ikinci sınıf limitlerini biraz aşmıştır. Toplam ve fekal koliform değerlerinde çok farklılıklar gözlenmiştir.Bazı aylar fekal koliforma rastlanmazken Şubat ayında 3 istasyondan

alınan örneklerde diğer aylarınkine göre bariz bir artış olmuştur. Total koliform miktarlarında yaz aylarındaki artış bütün istasyonlarda genel olarak paralellik göstermektedir. Total ve fekal koliform değerlerinin yüksek olmasında yerleşim merkezlerinden gelen evsel atıkların arıtılmadan gölü besleyen derelere deşarj edilmesi ve bazı yerleşim merkezlerinin göle çok yakın olması rol oynamaktadır.

Sonuçlar standartlarla karşılaştırıldığında farklı istasyonlardan alınan örneklerde mevsim şartlarına bağlı olarak farklılıklara rastlanmıştır. Bu farklılıklar mikrobiyal kirliliğin boyutları hakkında bir ipucu vermiştir. Gözlenen bu farklılıkların göldeki organik madde miktarının ve iklimsel faktörlerin değişimine bağlı olduğu düşünülmektedir.

Ayrıca seçilen dört istasyonun konumlarına göre sonuçlarımızı karşılaştırdığımızda kirliliğin kaynakları hakkında bilgi sahibide olunmuştur. Elde edilen bu sonuçlara göre Büyükçekmece gölünün gölü besleyen akarsuların çeşitli kaynaklardan getirdiği atıklarla kirlenmekte olduğu ortaya çıkmıştır. Bu kaynaklar göl havzasında bulunan Tepecik, Çatalca ve civar köylerin arıtılmadan gölü besleyen derelere salınan kanalizasyon ve evsel atıklarıdır.

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LIST OF SYMBOLS

BOD : Biochemical Oxygen Demand.

BOD_5 : 5-day Biochemical Oxygen Demand.

COD : Chemical Oxygen Demand.

FAS : Ferrous Ammonium Sulphate.

ORP : Oxidation Reduction Potential.

BÇL : Büyükçekmece lake.

ORM : Open Reflux Method.

WM : Winkler Method.

MPN : Most Probable Number.

BGB : Brilliant Green Bile Broth.

LB : Lactose Broth.

EC : *Escherichia coli.*

MT : Multiple-Tube Method

MF : Membrane Filter Technique

1. INTRODUCTION

In today's world, water sources have become scarce natural resources and they have become difficult and expensive to obtain. Sharing water sources may cause disputes and conflicts between countries- such as the case between Turkey and Syria. The reason of this kind of problems does not stem from water sources' becoming less, but rather it relies under the fact that both water consumtion and water pollution is increasing as a result of rapid population growth, urbanization, and industrialisation. Especially water and environmental pollution has become an issue which scientists have been arguing about and doing researc into. Also goverments and related institutions have made greate sums of investment on the issue have tried to prevent and settle the problem by passing special laws.

In countries where society's health is given major importance, preventing the water sources and the environment from getting polluted and taking everthing into concideration to take necessary measurements is something taken seriously. United States of America, Europian Community Countries, Japan, and Canada would be some certain countries to be given as examples to this.

Nowadays in such devoloped countries water quality and its amount are inseperable concepts. Because it is an obvious fact that putting the water with no proper quality to use will lead to severe health problems and sooner or later economic social loss of it wil be paid back by the society itself. Society's being avare of this and having a strong awareness about it is, with no doubt, the most vital point in settling the problem.

It is an unarguable fact that water is one of the most importante substances for a healthy life. It is imposible to be hygenic when there is not adeguate and clean water [1].

The leading cause for epidemics is microbiologic pollution of drinking water which is caused by lack of sanitation [2].

Through drinking water various bacteria, virus, protozoon, and helmint infections might occur. These infections are generally spreaded around by human or animal wastes [3, 4].

Pollution of water sources is important not only for health care but also for ecology. Water pollutin which is consequance of industrial wastes, sewages, fertilizers, pesticides, garbages, and other factors plays an important role in environmental care [5].

In Istanbul- a city with a population over ten millions, the most important industrial and commercial center of Turkey, and a world city – providing drinking and tap water has been the cities one of the most important problems and it is clear that so it will be in the future. The importance of this problem is getting bigger parallel with the growth of the city its self. The enlargement and growth of the city and industriallisation has increased both water demand and pollution in current water sources. In Istanbul the expansion of the city has reached up to the water deposits, and even in same areas it has started to threaten protection areas. Büyükçekmece and Tepecik towns are typical sample for this point [6, 7].

Detecting and determining the hole pathogenic microorganisms to see if water is healthy or not is quite difficult because of their being scarce. Instead of these, the presense of coliform group bacteria is researched as an indicator of whether the water is contaminated with any waste [3, 4, 8].

By researching some bacteriological pollution parameters in Büyükçekmece lake which is a reservoir for drinking and using, it is aimed to find out the sources of the pollution of the lake, the extent of pollutions, and also to contribute in the subject of precautions which will have been taken later on.

2. GENERAL INFORMATION

When we concider the ratio of water in the body of a living thing, we can see how important the water is as a source of life.

Throughout the history, mankind, who has established numerous civilizations has always considered the existence of water sources nearby while chosing a place to settle down, and he sought ways to bring adequate and healthy water to the places they settled down. The importance of water has risen continually in proportion with social and cultural devolopments, and increasing population.

For the maintanance of life, the water which has that much significance, should have some certain qualities in order not to threaten our health. Consequently, there are some standards and definitions about water quality brought about by various countries and World Health Organisation [1] .

Drinking water is the one which is used for drinking, in making and preparing food and in personal or general cleaning [9].

Pollution of water, which is directly related with human health, by sewage, industrial wastes, pesticides garbage and other factors is threatening the social health severely. For instance, if drinking water is polluted with sewage epidemics such as cholera, dysentery etc. may spread around quickly [5].

Some of the microorganisms that are infected by water and have the risk of serius epidemic are bacteria such as *Salmonella* sp., *Shigella* sp. Enteropathogenic *Escherichia coli, Vibrio cholerae, Yersinia* sp., *Campylobacter jejuni, Campylobacter coli, Leptospira, Legionella* sp.; viruses (*Astrovirus, Calicivirus, Enteroviruses '' Poliovirus, Coxackievirus, Echovirus '', Hepatit A virus, Hepatit E virus, Norwalkvirus, Group A* and *B Rotavirus)* and parasites (*Giardia, Cryptosporidium, Entamoeba histolytica* and *Dracunculus medinensis).*[3, 4, 10].

In cases infected by means of water various factors play role related with motive and atmosphere. Pathogens with infection capability lose their this capability and livelyness after they leave the host body and these microbes can not propogate

in waters. Spoiling generally speeds up with an increase of water temperature and UV rays in sunlight that affects the water surface has a fatal effect [4, 11, 12] .

Water including carbon enough to decompose with bacteria warm temperature and low clor concentration may allow *Legionella* sp., *Naegleria fowleri, Acanthamoeba* sp., and opportunist pathogens such as *Pseudomonase aeruginosa,* and *Aeromonas* sp. to breed.[4].

These factors can pass into a human body by means of contaminated drinking waters, food made with this water, or bathing hit it. That's why the water we use for preparing food, washing and cleaning must have the quality of drinking water [4].

3. REVIEW OF THE LITERATURE

3.1. Water Pollution in the World and Turkey.

Nowadays; the problem of the enviromental pollution threatening the social health due to misuse of source, industrialization, wrong settling in cities and insufficiency of infrastructure. People get use of water for many purposes. Many times, water is wasted, directed in a wrong way. World have already understood the results. As people's living condition increase, water demand increase even more than that. The amounth that falls 800 m^3 to a person for a year, since 1950, there is a continuing increase with a 50 %. By realising the importance of water while they are compensating their necessity, the studies are began in this century about the water's economic, ecologic and political boundaries. Developed countries, began to studies to find out the solutions for water pollution, and they recorded outstanding progresses in solving of the environmental problems [13].

In Amsterdam-Holland, Medama and Schets found out the correlation between fecal pollution and trophic concerned *Plesiomonas shigelloides* density which is a water originated gastro- enterit agent in recreational beaches and which is searched for a bacterial pollution indicator in fresh waters [14].

Turick et al. has proposed to use fecal pollution as a bacteriologic water quality indicator which is formed at water columns of a fresh water mussel (*Elliptio complanato)* that is showing and accumulation property of the water fecal coliforms in its structure and is behaving as an active filter [15].

Palmer et al. detected some indicator organisms at the disposal washing waters of Ontorio- Canada loading harbours. They found out the values of fecal coliform density as 10^5- 10^8 / 100 ml. and observed that the values are much higher than the standarts [16].

Eashwar et al. have put out the existence of *Thiobacillus* at the waters of Tuticarin harbour in India. In this work researchers found out the propagation of *Thiobacillusses* at the beach waters coming from harbour waters besides their property of determining pollution level [17].

Islam et al. has examined the condition of fecal pollution between May 1988-April 1989 in a period of the year at the surroundings and center of Dhaka-Bangladesh. And it was concluded that four of the water resources are underwent to fecal pollution in high measures and these waters have a potential danger for public health [18].

Neimi et al. found out the relation between parameters at bacterial concentrations, excreation and chemical water quality by investigating the longterm temperal chances of fecal streptococci together with thermotolerant coliform bacteria in Aurajoki river, Finland [19].

Niemi and Niemi had compared the fecal indicators of water samples taken from 3 waste water trial stations in which these indicators are used for a comparison at a study in determination of thermotolerant coliform bacteria concentrations, and also a for existence of possible *E. coli* and posible fecal streptococci from waters of 22 disturbed regions and 6 agricultural regions. As a consequence they discovered that in agricultural and undisturbed natural waters, there is an increase of bacteriologic pollution in winter months [20].

Falcoa et al. are examined the potential pathogenic and pathogenic bacteria of different fresh waters at Araraquara region of Brasil. At the results of counting of heterotrophic microorganisms at 99 water sample which is taken from rivers, rezervoirs, artesien and pool waters; EPEC, ETEC and EIEC variants of fecal coliforms and *Shigella, Salmonella, Yersinia, Mycobacterium* and *E. coli* could not be isolated. According to researchers these waters have a potential microbiologic health risk [21].

In Turkey, the problems of water pollution, firstly began with the pollution of Golden Horn. Turning into a domestic and industrial wastes carrier sewerage, awakened very big echoes. Izmit and Izmir Gulf pollutions, Porsuk Stream pollution are following this. Since the necessary precautions or enough precautions did not take, pollution is spreaded to every part of our country. Parallel to this firstly universities and then civil social organizations studies are accelerating in controlling and prevention of environmental pollution.

Boztepe, by studying on determination of some pollution parameters at Seyhan river, he pointed out that the water is not suitable for the standards [22].

Algur had studied on the microbiologic analysis of drinking waters at some villages of Erzurum plain. He determined from the 62 samples (51,6 %) total bacteria count is more than 500 / ml., from the 69 samples (57,5 %) coliform bacteria, and from the 55 samples (48,5 %) there is fecal coliform bacteria [23].

Türkman had examined some pollution parameters at side brooks which pours to Izmir Gulf. As a concequence, he pointed out the effects of water resources which examined by him to Izmir Gulf [24].

Yılmaz examined the pollution parameters at Izmir underground waters.Pointed out how polluter resources effect underground waters and what are their levels [25].

Kolankaya et al. examined the waste of Seka factory (Çay- Afyon) by way of physical, chemical, and bacteriological pollution parameters. Researhers found out the effect of waste water to Karamık lake [26].

Erdur brought out the being of the nitrogen pollution at river and brooks which are poured into Izmir Gulf [27].

Özdemir examined some bacteriological pollution parameters at Melez stream which is poured into Izmir Gulf. He compared the fitness of parameters to standards, and as a consequence detected that most of these are above the standards [28].

Kırımhan et al. observed the water quality of Hazar lake- Elazığ between April 1992- September 1992 monthly. At the result of study, they pointed out there is an increase at bacteriologic pollution at the summer seasons [29].

Dülger examined some bacteriological pollution parameters at Bursa Nilüfer Stream. He determined that most of these parameters are much above the standards and also determined that Nilüfer stream is in its most polluted state by the industrial and domestic wastes [30].

Köksal examined the water resources of Istanbul by pathogenic intestinal bacteria. She determined the ratios of coliform bacteria, excrement based *E.coli,*

Aeromonas and *Vibrio* origins in crude waters, and also pointed out that there is no any species of *Salmonella, Shigella, Yersinia,* and *Campylobacter* sp. in the examined water samples [1].

Samastı et al. examined Terkos lake and its brooks, and Büyükçekmece lake. They found out > 1100 (MPN) coliform bacteria and in some samples there is intestinal *E. coli* [31].

Yıldız found out 100 % coliform bacteria, 25 % *E. coli* originated from intestine at Ömerli and Büyükçekmece lake waters [32].

3.2. Some Chemical and Biological Parameters for Detection of Water Pollution and Classification of Pollution Elements

A wide variety of tecniques can be used to evaluate the presence, types, and activities of microorganisms in the environment. Many of these tecniques were developed during the '' golden age of discovery '' in the last part of the nineteenth century. These include viable counting, microscopic procedures, and measures of nutrient cycling. Statistics are becoming critical for all of these techniques because of increased demands for reliable results, quantitative sampling, and selection of the best sampling size and number of replications. Before initiating microbial studies, it is best to have a strong statistical framework available, even for a '' simple '' technique such as counting bacterial cells in a water sample.

With environmental samples that contain higher levels of nutrients and microorganisms, such as polluted waters and sewage, organic carbon can be measured by the biochemical oxygen demand (BOD) and chemical oxygen demand (COD) procedures [33].

It is tought that the surface water is a medium which carries away the waste water and other wastes, to understand the effects which brought to the ecology by these wastes, it is useful to classify the pollution which is brought by the surface water [34].

3.2.1. Classification of the Polluted Effects at Surface Waters according to World Health Organisation (WHO).

Reasons of pollution at surface waters are classfied as follows [35].

a) Bacteria,viruses and the other pathogenic organisms.

b) Pollution which originated from organic substances.

c) Industrial wastes.

d) Oils and similar substances.

e) Synthetic detergents.

f) Radioactivity.

g) Pesticides.

h) Artificial organic substances.

i) Inorganic salts.

j) Artificial and natural fertilizers.

k) Waste heat.

3.2.2. Classification of Inland Surface Waters

Classification of inland surface waters stored in rivers, lakes, and barrages is given below [36].

Class 1. High quality water

Class 2. Less polluted water

Class 3. Polluted water

Class 4. Most polluted water.

Water quality critaria for classification and their limits for classes 1, 2, 3, 4 are given seperately in table 1.

According to the official paper of Turkish Republic, these four types of water are suitable for following water requirements [36].

Class 1. High Quality Water

a) Obtaining of drinking water with only disinfection
b) Recreational aims (including swimming, etc.)
c) Speckled trout production
d) Animal providing and farm necessity
e) The other aims.

Class 2. Less Polluted Water

a) Obtaining of drinking water with suitable filtration
b) Recreational aims
c) Fish production except speckled trout
d) Obtaining of irrigation water (it must be suitable for watering critaria)
e) The other usages except class 1.

Class 3. Polluted Water

It is suitable industrial water obtain after the suitable point except required quality water such as nutriment and textile industries.

Class 4. Most Polluted Water

It refers surface waters which have more less quality according to class 1, 2, and 3.

Table 1. Quality criteria of inland water sources [36] .

Water Quality Parameters	Quality of Water I	II	III	IV
1. Temperature (^{0}C)	25	25	30	>30
2. pH	6.5-8.5	6.5-8.5	6.0-9.0	(out of 6.0-9.0)
3. Dissolved O_2 (MgO_2/1)	8	6	3	<3
4, Ionic Sulphate (Mg $S0_4$/1)	200	200	400	>400
5. Ammonium Nitrate ($MgNH_4$-N/l)	0.2[b]	1[b]	2[b]	>2
6. Nitrite ($MgNO_2$-N/1)	0.002	0.01	0.05	>0.05
7, Nitrate ($MgNO_3$-N/l)	5	10	20	>20
8. Total Phosphorus ($MgPO_4$-P/l)	0.02	0.16	0.65	>0.65
9, Total Dissolved Matter (mg/l)	500	1500	5000	>5000
Organic Parameters				
1. COD (mg/l)	25	50	70	>70
2. BOD (mg/l)	4	8	20	>20
3. Organic Carbon (mg/l)	5	8	12	>12
4. Total Pesticides (mg/l)	0.001	0.01	0.1	>0.1
Inorganic Parameters				
1. Mercury (mg/l)	0.1	0.5	2	>2
2. Chromium (gCr/l)	20	50	200	>200
3. Manganese (gMn/1)	100	500	3000	>3000
4. Cadmium (gCd/l)	3	5	10	>10
5. Lead (gPb/I)	10	20	50	>50
Bacteriological Parameters				
1. Fecal Coliform (MPN/lOOml)	10	200	2000	>2000
2. Total Coliform (MPN/lOOml)	100	20000	100000	>100000

3.2.3. Sampling and Storage for Determination of Water Pollution.

Samples are collected for microbiological examination in bottles that have been cleansed and rinsed carefully, given a final rinse with distilled water, and sterilised. For some applications samples may be collected in sterilised plastic bags [37,38].

When the sample is collected, ample air space is left in the bottle (at least 2.5 cm) to facilitate mixing by shaking, before examination [37,38].

Sampling bottle is kept closely until it is to be filled. Stopper and cap are removed as a unit; to against contamination of inner surface of stopper or cap and neck of the bottle. Container is filled without rinsing, stopper or cap is replaced immediately [37,38].

Microbiological examination of a water sample is started promptly after collection to avoid unpredictable changes. If samples cannot be processed within 1 h after collection, an iced cooler is used for storage during transport to the laboratory. If it is known that results will be used a legal action, a special messenger is employed to deliver samples to the laboratory within 6 h and maintain the chain of custody [37,38].

Temperature of all stream pollution, drinking, and wastewater samples are held below 10^0C during the maximum transport time of 6 h. These samples are refrigerated upon receipt in the laboratory and are processed within 2 h. When local conditions necessitate delays in delivery of samples longer that 6 h, either making field examinations using field laboratory facilities located at the site of collection or using delayed-incubation procedures are considered [37,38].

Unfortunately, these requirements seldom are realistic in the case of individual potable water samples shipped directly to the laboratory by mail, bus, etc., but the time elapsing between collection and examination should not exceed 24 h. Where refrigerator of individual water samples sent by mail is not possible, a thermas-type insulated sample bottle (or equivalent) that can be sterilised may be used. Time and temperature of storage of all samples are recorded and this information in the interpretation of data is considered [37,38].

3.2.4. Sample Types.

According to Şengül and Türkman, sample types are divided into three groups. These are grab and onspot samples, composite samples and integrate samples [34].

3.2.4.1. Grab and Onspot Samples.

When the sample is taken at certain time and location, this sample is represented only at this time and location. Some resources can be represented very good by single grab sample, such as some surface waters and wastewaters, etc. When known that the source is changeable according to time, grab sample is taken and analysed in suitable time period. If the

union of the taken sample is changeable according to sites, samples are taken to the suitable sites.

3.2.4.2. Composite Samples.

These samples are used for the measurement of productivity of refinement establishing. When the composite samples are a single sample instead of many samples, they are very suitable for the sample expenditure in the laboratory.

3.2.4.3. Integrate Samples.

Integrate samples are the mixture of grab samples which are taken to a different sampling site. Mixed grab samples are analysed for necessary information of some aims.

According to Radier, 1 liter water sample is enough for the most of physical and chemical analyses. The bigger sample values can be used in some special analyses [61]. Some sample values are given for different analyses in table 2.

3.2.5. Storage of Samples

Storage techniques are delayed the changes of chemical and biological after the taking of sample. Temperature can change very quickly. pH can change according to minutes, dissolved gasses can disappear. For that reason, temperature, pH, and dissolved oxygen are measured at sampling location.

Transport period must be very short, for the most correct results. By storage of samples at cold and dark conditions changes are delayed. Table 2. contains some storage techniques for different parameters [34].

Table 2. Sampling and storage techniques for different parameters [34,38].

Parameters	Sample vessel	Minimum Sample Value (*ml*)	Storage / or defence
BOD_5	P	100	---
COD	P,G	100	quickly as soon as possible
pH	P,G(B)	---	to analyse immediately
Temperature	---	---	to analyse immediately
Total coliform	G	100	to analyse within two hours
Fecal coliform	G	100	to analyse within two hours

P : Polyethylene or similar substance

G : Glass

G (B) : Glass, Borocilicate

3.2.6. Determination of Biochemical Oxygen Demand (BOD)

The amount of organic matter in water or wastewater can be measured directly (as TOC, for example), but this does not tell us whether the organics are biodegradable or not. To measure the amount of biodegradable organics, we use an indirect method in which we measure the amount of oxygen used by a growing microbial population to convert (oxidize) organic matter to CO_2 and H_2O in a closed system. The oxygen consumed, or BOD, is proportional to the organic matter converted, and therefore BOD is a relative measure of the biologically degradable organic matter present in the system. Because biological oxidation continues indefinitely, the test for ultimate BOD has been arbitrarily limited to 20 days, when perhaps 95% or more of the oxygen requirement has been met. Even this period, however, is

too long to make measurement of BOD useful, so a 5-day test, BOD_5, carried out at 20 °C, has become standard. The rate of the BOD reaction depends on the type of waste present and the temperature and is assumed to vary directly with the amount of organic matter organic carbon present a first-order reaction [39].

Analyses of organics are made to assess the concentration and general composition of organic matter in raw water supplies, wastewater, treated effluents, and receiving waters; and to determine the efficiency of treatment processes [40].

The BOD test is used for determining the relative oxygen requirements of municipal and industrial wastewater. Application of the test to organic waste discharges allows calculation of the effect of the discharges on the oxygen resources of the receiving water. Data from BOD tests are also used for the development of engineering criteria for the design of wastewater treatment plants [41].

Analysis for organic matter in water and wastewater can be classified into two general types of measurements; those that quantify an aggregate amount of organic matter comprising organic constituents with a common characteristic and those that quantify individual organic compounds.

Methods for total organic carbon and COD are used to asses the total amount of organics present. Gross fractions of the organic matter can be identified analytically, as in the measurements of BOD, which is an index of the biodegradable organics present, oil and grease, which represents material extractable from a sample by a nonpolar solvent or dissolved organic halide (DO), which measures organically bound halogens [40].

The method consists of filling with sample, to overflowing, an airtight bottle of the specified temperature for five day. Dissolved oxygen is measured initially and after incubation, and the BOD is computed from the differece between initially and after incubation, and the BOD is computed from the difference between initial and final dissolved oxygen is determined immediately after the dilution is made. Biochemical oxygen demand data have wide application in sanitary engineering practice. It is the principal test applied to sewage and industrial wastes to determine strength in terms of oxygen required for stabilisation. It is the only test applied that gives a measure of the amount of biologically oxidizable organic matter present that can be used to determine the rates at which oxidation

will occur, or BOD will be exerted, in receiving bodies of water. BOD therefore the major criterion used in stream pollution control where organic loading must be restricted to maintain desired dissolved oxygen levels. The determination is used in studies to measure the purification capacity of streams and serves regulatory authorities as a means of checking on the quality of effluents discharged to such waters.

BOD is usually defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic conditions. The term "decomposable" may be interpreted as meaning that the organic matter can serve as food for the bacteria, and energy is derived from its oxidation.

The BOD test is essentially a bioassay procedure involving the measurement of oxygen consumed by living organisms (mainly bacteria) while utilizing the organic matter present in a waste, under conditions as similar as possible to those that occur in nature. In order to make the test quantitative, the samples must be protected from the air to prevent reaeration as the dissolved oxygen level diminishes. In addition, because of the limited solubility of oxygen in water, about 9mg/L at 20 °C, strong wastes must be diluted to levels of demand in keeping with this value to ensure that dissolved oxygen will be present throughout the period the test.

Mixed culture of organisms derived from domestic sewage, contain large numbers of saprophytic bacteria and other organisms that utilize the carbonaceous matter present in the samples subjected to BOD analysis, and use oxygen in a corresponding amount. In addition, they normally contain certain autotrophic bacteria, particularly nitrifying bacteria, which oxidize noncarbonaceous matter for energy. The nitrifying bacteria are usually present in relatively small numbers in untreated domestic sewage, and fortunately their reproductive rate at 20 °C is such that their populations do not become sufficiently large to exert an appreciable demand for oxygen until about 8 to 10 days have elapsed in the regular BOD test.

Once the organisms become established, they oxidize nitrogen in the form of ammonia to nitrous and nitric acids in ammounts that introduce serious error into BOD work.

It is true that the the oxidation of inorganic nitrogen can deplete the dissolved oxygen in stream and the engineer must take lakes and this affect into account. However, it is not desirable to use normal BOD measurements for such estimates, because ammonia nitrogen is added to BOD dilution water as a required nutrient and its oxidation could lead to

erroneous conclusions about the waste. The potential dissolved oxygen utilization by nitrification is best evaluated by an analysis of this waste for the different forms of nitrogen present and use of stoichiometric relationship between oxygen and nitrogen.

The interference caused by nitrifying organisms makes the actual measurement of total carbonaceous BOD impossible unless provision is made to eliminate them. The interference caused by the nitrifying bacteria was a major reason for selecting a 5-day incubation period for the regular BOD test. All oxygen uptakes, including that occuring during the first 15 min is included in the BOD measurement [42].

The BOD test is an empirical biossay type procedure, which measures the dissolved oxygen consumed by microbial life while assimilating and oxidizing the organic matter present. The standard test conditions include dark incubation at 20 °C for a specified time period (often 5 days). The actual environmental conditions of temperature, population, biological, water movement, sunlight and oxygen concentration cannot be accurately reproduced in the laboratory. Results obtained must take into account the above factors when relating BOD results to stream oxygen demands.

Shortly, the sample of waste, or an appropriate dilution, is incubated 5 days at 20 °C in the dark. The reduction in DO concentration during the incubation period yields a measure of the BOD [41].

3.2.7. Determination of Chemical Oxygen Demand (COD)

Chemical oxygen demand refers to the amount of oxygen required to oxidize the organic compounds in a water sample to carbon dioxide and water. Under specific conditions of oxidizing agent, temperature and time [33].

The test involves using strong chemical reagents to oxidize the organics. For the different oxidizing reagents that are available, a stoichiometric equation is used that will relate the amount of oxygen needed to oxidize the organics to the amount of a chemical product formed. The chemical product can then be analyzed using indicator chemicals. The amount of indicator then will be proportional to the COD.

Since the test utilizes a rigorous chemical oxidation rather than a biological process, the result has no definable relationship to the BOD of the waste. The test result should be considered as an independent measurement of organic matter in the sample, rather than as a substitute for the BOD test.

The method can be applied to domestic and industrial waste samples having an organic carbon concentration greater than 15 mg/L. (When the chloride concentration of the sample exceeds 2000 mg/L, the modification for saline waters is required) [41].

The COD test is widely used as a means of measuring the pollution strength of domestic and industrial wastes.

The chemical oxygen demand is used as a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant [43].

It is applicable to the analysis of surface waters, domestic and industrial wastes with low characteristic [41].

For samples from a specific source, COD can be related empirically to BOD, organic carbon, or organic matter [43].

During the determination of COD, organic matter is converted to carbon dioxide and water regardless of the biologicalassimilability of the substances. For example, glucose and lignin are both oxidized completely. As a result, COD values are greater than BOD values and may be much greater when significant amounts of biologically resistant organic matter is present.

The major advantage of the COD test is the short time required for evaluation. The determination can be made in about 3 hour rather than the 5 days required for the measurement of BOD. For this reason it is used as a substitudete for the BOD test in many instances. Cod data can often be interpreted in terms of BOD values after sufficient experience has been accumulated to establish reliable correlation factors.

One of the chief limitations of the COD test is its inability to differentiate between biologically oxidizable and biologically inert organic matter. In addition, it does not provide any evidence of the rate at which the biologically active material would be stabilized under conditions that exist in nature.

The COD test is precise and accurate for samples with a COD of 50 mg/L or greater. For more dilute sampples it is preferred that a more dilute dichromate solution be used so that a significant relative difference between the quantity of dichromate added and that remaining after refluxing results. With dilute samples, care must be exercised to avoid sample contamination, and good analtical techniques must be used if reasonably accurate results are to be obtained. It is also important in any modification that the volume of sample plus dichromate solution be maintained at a 1:1 ratio. If it is smaller, the oxidizing power of the solution will decrease significantly, while if it is larger, the blank consumption of dichromate becomes excessive [41].

Most types of organic matter are oxidized by a boiling mixture of chromic and sulfuric acids. A sample is refluxed in strongly acid solution with a known excess of potassium dicromate (K_2CrO_7).

After digestion, the remaining unreduced K_2CrO_7 is titrated with FAS to determine the amount of K_2CrO_7 consumed and the oxidizable organic matter is calculated in terms of oxygen equivalent [44].

Both the COD and BOD tests are designed to measure oxygen requirements by oxidation of organic matter present in the samples. It is important, therefore, that no organic matter from outside sources be present or a true measure of the amount present in the samples to be obtained. Since it is impossible to exclude extraneous organic matter in the BOD test and impractical to do so in the COD test, blank samplesare required in both determinations.

A very marked change in ORP occurs at the end point of all oxidation-reduction reactions. Such changes may be readily detected by electronicmeans if the necessary equipment is avaliable. Ox-Red indicators may also be used; Ferroin (ferrous 1,10-phenantrolin sulfate) is an excellent one to indicate when all dichromate has been reduced by ferrous ion. It gives a very sharp color change that is easily detected in spite of the green color produced by the Cr^{+3} formed on reduction of the dichromate [41].

The dichromate reflux method is preferred over procedures using other oxidants because of superior oxidizing ability, applicability to a wide variety of samples, and ease of manipulation.

Oxidation of most organic compounds is 95 to 100 % of the theoretical value pyridine and related compounds resist oxidation and volatile organic compounds are oxidized only to the extent that they remain in contact with the oxidant [43].

Chemical oxidizing agents have long been used for measuring the oxygen demand of sewage and polluted waters.

Organic substances in the sample are oxidized by potassium dichromate in 50% sulfuric acid solution at reflux temperature. Silver sulfate is used as a catalyst and mercuric sulfate is added to remove chloride interference. The excess is titrated with standard ferrous ammonium sulfate, using ferroin complex as an, indicator.

To reduce loss of volatile organic, the flask should be cooled during addition of the sulfuric acid solution [41].

In any metod of measuring COD an excess of oxidizing agent must be present to ensure that all organic matter is oxidized as completely as is within the power of the reagent. This requires that is reasonable excess being present in all samples. It is necessary, of course, to measure the excess in some manner so that the actual amount reduced can be determined. A solution of a reducing agent is ordinarily used.

Nearly all solutions of reducing agents are gradually oxidized by oxygen dissolved from the air unless special care is taken to protect them from oxygen. Ferrous ion is an excellent reducing agent for dichromate. Solutions of it can be best prepared from ferrous ammonium sulfate which obtainable in rather pure and stable form. In solution, however, it is only oxidized by oxygen, and standardization is required each time the reagent is to be used. The standardisation is made with the 0,25N dilution of dichromate. The reaction between ferrous ammonium sulfate and dichromate may be represented as follows.

Potassium dichromate is a relatively cheap compound, whic can be obtained in a high state of purity. The analytical reagent grade, after drying at 103 °C, can be used to prepare solutions of an exact normality by direct weighing and dilution to the proper volume. The dichromate ion is a very potent oxidizing agent in solutions that are strongly acid. The reaction involved may be represented in a general way as follows.

COD results are reported in terms of milligrams of oxygen. Since the equivalent weight of oxygen is 8, it would seem logical to use a N/8 or 0,125N solution of oxidizing

agent in the determination, so that results can be calculated in accordance with the general procedure.

Experience with the test has shown that it has sufficient sensitivity to allow the use of a stronger solution of dichromate, and a N/4 or 0,25N solution is recommended. This allows the use of larger samples by doubling the range of COD that can be measured in the test procedure, since each milliliter of a 0,25N solution of dichromate is equivalent to 2mg of oxygen. It is based upon the fact that all organic compounds, with a few exceptions, can be oxidized by the action of strong oxidizing agents under acid conditions. The amino nitrogen will be converted to ammonia nitrogen. However organic nitrogen in higher oxidation states will be converted to nitrate [44].

Potassium dichromate has been found to be most practical off all of other oxidizing agents, since it is capable of oxidizing a wide variety of organic substances almost completely to carbon carbon dioxide and water. Because all oxidizing agents must be used in excess, it is necessary to measure the amount of excess remaining at the end of the reaction period in order to calculate the amount actually used in the oxidation of the organic matter. It is relatively easy to measure any excess of potassium dichromate, an important point in its favor [43].

In order for potassium dichromate to oxidize organic matter completely, the solution must be strongly acidic and at an elevated temperature. As a result, volatile materials originally present and those formed during the digestion period are lost unless provision is made to prevent their escape. Reflux condensers are ordinarily used for this purpose and allow the sample to be boiled without significant loss of volatile organic compounds [45].

Certain organic compounds, particularly low-molecular weight fatty acids, are not oxidized by dichromate unless a catalyst is present. It has been found that silver ion acts effectively in this capacity. Aromatic hydrocarbons and pyridine are not oxidized under any circumstance [41].

Straight-chain aliphatic compounds are oxidized more effectively when silver sulfate (Ag_2SO_4) is added as a catalyst. However Ag_2SO_4 reacts with chloride, bromide and iodide to produce precipitates that are oxidized only partially.

The difficulties caused by the presence of the halides can be overcome largely, though not completely, by complexing with mercuric sulfate ($HgSO_4$) before the refluxing procedure.

Although 1 g $HgSO_4$ is specified for 50mL sample a lesser amount may be used where sample chloride con is known to be less than 2000mg CL/L, as long as a 10:1 ratio of $HgSO_4$ CL is maintained. Do not use the test for samples containing more than 2000mg CL/L Techniques designed to measure COD in saline waters are available.

3.2.8. Determination of Temperature

Heat is also industrial waste that is discharged into water; heated dis charges may drastically after the ecology of a stream or lake. Although such local heating can have beneficial effects like freeing harbors from ice, the primary effect is deleterious: lowering the solubility of oxygen in the water, because gas solubility in water is inversely proportional to temperature, and thereby reducing the amount of DO available to gill-breathing species. As the level of DO decreases, metabolic activity of aerobic aquatic species increases, thus increasing oxygen demand [46].

In limnological studies, water temperatures as a function of depth often are required. Elevated temperatures resulting from discharges of heated water may have significant ecological impact. Identification of source of water supply, such as deep wells, often is possible by temperature measurements alone. Industrial plant often require data on water temperature for process use or heat-tranmission calculation [47].

The discharge of heated water into a water can have a number of effects. An increase in temperature affects the physical properties of water such as the rate at which it evaporates its density, and its ability to dissolve its gasses. One of the most important effects is that as the temperature increases the amount of dissolved oxygen decreases. Not only does a rise in water result in decrease in the amount of dissolved oxygen but also it bring about in the aquatic organisms an inrease in the rate oxygen consumption and biochemical reactions. Thus the metabolism of fish and microorganisms is increased, further depleting the amount of available oxygen. Elevated temperatures also result in the decrease in the affinity of hemoglobin free oxygen. Heated water, by decreasing the amount of oxygen in the water, has

still other effects. Potentially toxic substances present in sublethal amounts with abundant oxygen become lethal when the dissolved oxygen is greatly reduced. For example, metal ions such as, nickel, zinc, iron, and selenium, present in sublethal amounts along with abundant oxygen may become lethal if the oxygen concentration is drastically reduced [48].

Deep lakes and reservoirs become thermally stratified, particularly during the summer months. Thermal stratification is caused by variations in the density of water in lakes and reservoirs. Water is at its densest at 4^0C, when it weighs exactly 1000 kg/m^2. However, either side of this temperature water is less dense. During the summer the sun heats the surface of the water reducing its density, so that the colder denser water remains at the bottom of the lake. As the water continues to heat up, then two distinct layers develop. The top layer or epilimnion is much warmer than the lower layer, the hypolimnion. Owing to the differnces in density, the two layers separated by a static boundary layer known as the thermocline, do not mix but remain separate [49].

Industrial cooling prolonged exposure may produce undesirable physiological effects, causes adverse effects on aquatic life taste and odour. [50].

3.2.9. Determination of pH

pH is the measure for the alkalinity or acidity of a substance. Like temperature, pH level effects both biological and chemical processes. The level of pH in an aquatic system can hinder the reproduction of certain organisms and can allow certain substances to become more readily available for uptake by aquatic plants and animals. Chemical process used to coagulate sewage or industrial wastes, dewater sledges, or oxidised certain substances, such as cyanide ion require that the pH be controlled within rather narrow limits. The pH of a solution is a measure of hydrogen ion concentration, which is in turn a measure of its acidity. Pure water dissociates slightly into equal concentrations of hydrogen and hydroxyl ions [49].

An excess of hydrogen ions make a solution acidic, whereas a decrease of hydrogen ions or excess of hydroxyl ions, makes its basic. pH is an important in almost all phases of water and wastewater treatment. Aquatic organisms are sensitive to pH changes and biological treatment requires either pH control or monitoring. In water treatment as well as disinfecting and corrosion control, pH is important in ensuring proper chemical treatment.

Due to presence of acids or alkalins higher or lower pH affects aquatic life and makes it unfit for human use [46].

3.2.10. Determination of Bacterial Pollution.

Water samples are examined bacteriologically for suitability or not. Methods are to determine the value of water pollution by means of human and animal wastes. Instead of pathogens, indicator organisms are determined and counted, such as coliform group microorganisms [34].

Isolation and definition of pathogenic microorganisms from waters are difficult. Presence of indicator microorganisms in the water sample is a demonstrator for presence of pathogenic microorganisms which originated from wastes and urine [3, 4, 8, 11].

100-400 billions coliform organisms and the other bacteria species are released from human wastes [60]. Pathogenic microorganisms are found with coliform bacteria and their ratio is 1 pathogen to 10 000 cloakrooms, according to tests [51].

All the organisations in the world (International Organisation for Standardisation [ISO], American Water Works Association [AWWA], American Public Health Association [APHA], US Public Health Service [USPHS], Water Pollution Control Federation [WPCF], World Health Organisation European [WHO-E], World Health Organisation International [WHO-I], United Kingdom Department of Health and Social Security are accepted the coliform bacteria as indicator microorganisms [11].

3.2.10.1. Indicator Bacteria for Fecal Contamination.

3.2.10.1.1. Total Coliform.

The amount of fecal contamination is monitored by counting the number of non-pathogenic, or indicator, bacteria and other microorganisms that are easily identified, almost completely fecal in origin, present in human sewage in large numbers, and that survive in water long enough to be satisfactorily counted. The coliform group comprises all of the facultative anaerobic gram-negative, non-spore-forming, rod-shaped bacteria that ferment lactose with gas formation within 24-48 hours at 35^0C. Even though all the cloakrooms will not come from feces, the total coliform count is used as an index of sewage pollution [3,11].

Escherichia, Enterobacter, Klebsiella, Citrobacter and Serratia genus and their species are members of coliform group bacteria. The bacterial organism that probably satisfies the fecal pollution best is *Escherichia coli.*

The number of the other coliform is more less according to *Escherichia coli.* Besides, these are found in soil and plants. These bacteria can be found in water without fecal contamination. For that reason, they are not evidence for presence of pathogenic microorganisms [4, 8,11,12].

Total coliform limits according to the classification of inland water sources are given in table 3 [36].

3.2.10.1.2. Fecal Coliform.

The number of the fecal coliform is changeable according to environmental conditions. They are found in different amounts at different areas. For instance, 10^9/1 g in human wastes; $10^6 - 10^8$/100 ml in refinemented sewerage mud; and $10^4 - 10^6$/100 ml in twice as in refined sewerage waters [52].

Fecal coliforms are indicator of newly formed fecal contamination in their life areas. Because of these species cannot reproduce in soil and sea medium, these bacteria groups are used as indicator of fecal contamination exactly [35].

Fecal coliform limits according to satisfaction of inland water sources are given in table 3 [36].

Table 3. Some pollution values according to classification of inland water sources [36].

	Water quality classes			
	I	II	III	IV
	High quality water	**Less polluted water**	**Polluted water**	**Most Polluted water**
BOD (mg/lt)	4	4-8	8-20	>20
COD (mg/lt)	25	25-50	50-70	>70
pH	6.5-8.5	6.5-8.5	6.0-9.0	6.0-9.0(out of)
Temperature (°C)	25	25	25-30	>30
Total Coliform (MPN/100ml)	100	100-20.000	20.000-100.000	>100.000
Fecal Coliform (MPN/100ml)	10	10-200	200-2000	>2000

4. GENERAL INFORMATION ABOUT BÜYÜKÇEKMECE LAKE

Büyükçekmece lake is in Marmara region and generally its surrounding hence a rough country. The average height is 80 – 90 m. When you go through seaside to inside the country you come to the plain area at 200 m. altitude. Here there is not any rough country. But north parts have hilly view because of valleys. But it is a little inclined through south. In north- south direction, floor of valleys are wide and brode [53].

In the north of the lake, there are Sarısu and Karasu brooks and in the west of the lake there is Çakıldere. Alluvion which is brought by Çakıldere fills this part. Therefore, shallaw part of the lake is here. The shapes shown by the valleys shows the maturity phase. There is 30 –40 m. relative height difference between valleys floor and smoothnesses [53].

In winter, in the rainy months, water level of the lake increases and through 200- 300 m. inside, it covers the plains. Therefore these plains becomes marsh. Near the lake there are filled areas which became grassy in the western part of the lake there is a small delta[53].

Area of the Büyükçekmece lake is 36km^2 but water collecting area is 622km^2.Total reserve is (162 x10 6m^3/year) total protection area 620km^2,absolute are 19km^2, short area is 34km^2, middle area is 44km^2[53].

The largest settlements near the lake are Büyükçekmece and Çatalca districts.In the water collecting are of the lake, there are 23 villages depending on Büyükçekmece and Çatalca, also 4 villages depending on Silivri. They have 41502 population according to 1985 cencus.

In the region, the most foundamental economical activity are agriculture and animal husbandry. Main grains are wheat and sunflower. In the last years, vegetables are grown by greenhouse. Dealing in poultry and putting to fatten are two main types for animal-husbandry. Besides, there are large and small industries.

Fixing the industry and animal husbandry foundations in water collecting area of Büyükçekmece lake goes up to 1981. According to the work done by ISKI,

the number of foundations is 41[53]. Beacause of establishment of Büyükçekmece dam, some of the water collecting area are being outside of this area. Therefore, the number of foundations in the lake's area is 32. But, from 1984 which is the year of work done up to this year, new foundation and closed foundations are being investigated.

According to tourism, this region is important because it is one of the summer houses of Istanbul. There are touristic foundations and hotels in the beach.

Construction of new highway in the northern part of the lake in Bahsayiş, causes new stone querries besides old ones. Also, in the southern part of the lake there is a highway E-5, in the southern –west part, there is Akçimento.

Three rills flowing in to Büyükçekmece lake are Karasu, Sarısu, and Çakıl rill. Büyükçekmece lake is the largest water source of the western part of İstanbul Constraction of the dam cut the connection of the lake by the sea and lake became a fres water lake (Figure 1) [53].

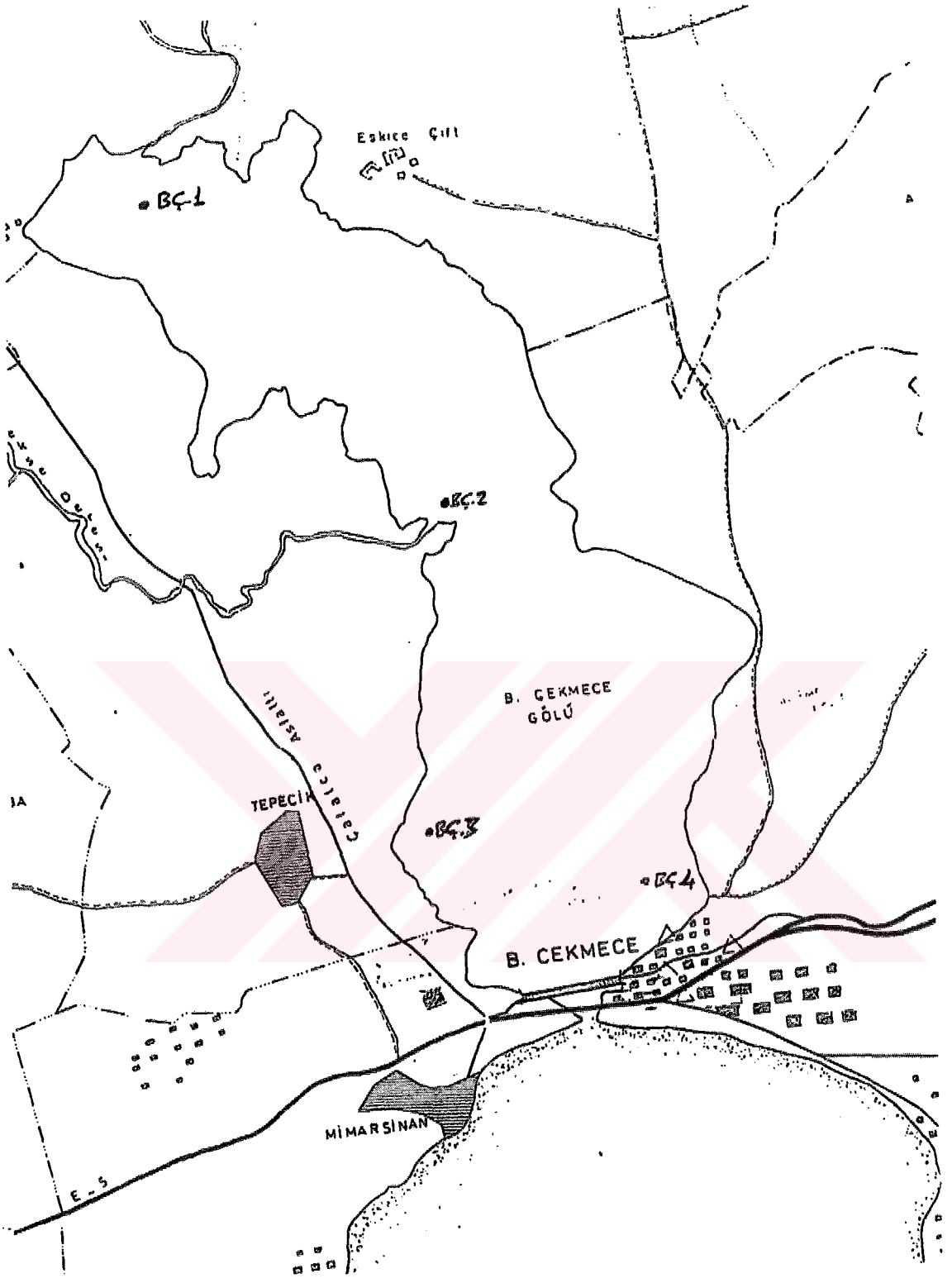

Figure 1. Sampling sites of Büyükçekmece lake.

Table 4. Settlement centers at Büyükçekmece lake region [53].

County	Settlement centers bound to county
ÇATALCA	Şehir (Çatalca)
	Akalan
	Bahsayış
	Çakılköy
	Çanakça
	Dağyenice
	Elbasan
	Gökçeli
	İnsaniye
	İnceğiz
	İzettin
	Kabakça
	Kestanelik
	Kızılcaali
	Muratbey
	Nakkaş
	Oklalı
	Ovayenice
	Örcünlü
	Subaşı
	Ahmediye
	Çakmaklı
	Tepecik
	Türkoba
SİLİVRİ	Akören
	Kadıköy
	Bekirli
	Kurfallı
TOTAL	28

5. MATERIAL AND METHOD

5.1. Material

5.1.1. Samples

Samples were taken from four stations of the lake according to grab and onspot sampling methods for determination of some bacteriological pollution parameters at Büyükçekmece lake. Samples were taken every month from the selected stations during January- December, 1999 (Figure 1 and Table 5).

Table 5. Important characteristics of sampling sites

Sampling Sites	Characteristics
BC 1. Bahsayiş Çevre Yolu Set Önü	Near discharge points of Sarısu and Karasu dere in north of the lake
BC 2. Çakıldere Deşarj Noktası	The area in west of the lake
BC 3. Tepecik Mevkii	In front of Tepecik town, and south-west of the lake
BC 4. Mezarlık Önü	East of the lake and near B. Çekmece

5.1.2. Media

Several different culture are avaliable for the presumptive test. (guideliness for drinking water quality) For example,

- Lauryl tryptose broth (LTP)
- Mac Cokey broth
- Lactose broth

These three media are in common use in many countries[12].

The selectivity of Mac Conkey broth and LTB depends respectively on the presence of bile salts and the surface active agent, Lauryl sulfate; Lactose broth is a non-selective medium.

As a confirmatory medium for total coliforms Brilliant Green Lactose Bile Broth (BGB) is most widely used [12].

To confirm the presence of fecal coliforms, either BGB broth or Escherichia coli (EC) broth is used [12].

We selected these media as an indicator of bacterial pollution in our work. Preparation of these media are as follows:

Medium 1. "Lauryl tryptose or Lactose broth" [54]

Contents	Single	Double
Beef extract	3.0g	6.0 g
Peptone	5.0 g	10.0 g
Lactose	5.0 g	10.0 g
Distilled water	1000.0 ml	1000.0 ml

Ingredients are dissolved in the distilled water at boiling point. pH should be between 6.8 and 7.0, but preferably 6.9 after sterilisation.

Each of the 3 raws (more in case the expected MPN of fecal coliform is high) of 5 clean culture tubes are placed in an autoclevable test tube rack. Then inverted vials are added to all culture tubes and sufficient medium is dispensed into the culture tubes so that the inverted vials are at least particularly covered after the entrapped air in these vials has been

driven out during autoclaving. Double-strength broth is transferred into the first row of these culture tubes. Single-strand broth is transferred into the second and third rows (and if necessary into successive rows) and the tubes are closed with cotton plugs. The closed culture tubes are autoclaved at 121 ^{0}C for 15 minutes. pH is adjusted between 6.8 and 7.0 [54].

This medium is used for determination of most probable numbers of total and fecal coliform and it is used to presumptive test.

Medium 2 "Brilliant Green Lactose Bile Broth" [54]

Contents	Amounts
Oxgall, dehydrated	20,0 g
Lactose	10,0 g
Peptone	10,0 g
Brilliant green	13,3 g
Distilled water	1000,0 ml

The chemicals are dissolved in one liter of distilled water. Then inverted vials are added to all the culture tubes and sufficient medium dispensed into the culture tubes so that the inverted vials are at least partially covered after the entrapped air in the vials has been driven out during autoclaving. The tubes are closed with cotton plugs. The closed culture tubes are sterilised by autoclaving at 121^{0}C, preferably for 12 minutes, but not exceeding 15 minutes. After sterilization, the broth is cooled as quickly as possible. Final pH should be 7,0 ± 0,2. The 5 plugs of the finished product are tested for performance using control stuck cultures [54].

This medium is used for determining the number of total and fecal coliforms by most probable number method (MPN) in confirmed test.

Medium 3. "LES Endo agar" [54]

Contents	Amounts
Peptone	10.0 g
Lactose	10.0 g
Dipotassium Phosphate	3.5 g
Sodium Sulphite	2.5 g
Basic Fucksin	0.5 g
Agar	15.0 g
Distilled Water	1000.0 ml

Ingredients (41.5 grams) are suspended in 1000.0 ml of distilled water at boiling point. Final pH should be 7.5 ± 0.2. Medium is distributed into tubes or flasks and is sterilised by autoclaving at 121^{0}C for 15 minutes. Sterilised medium is dispensed into petri dishes for streaking of cultures [54].

Endo agar is used for streak inoculation of cultures in completed test. On LES Endo agar, coliforms produce reddish colonies.

Medium 4. "EMB Agar" [54]

Contents	Amounts
Peptone	10.0 g
Lactose	5.0 g
Sucrose	5.0 g
Dipotassium Phosphate	2.0 g
Agar	13.5 g
Eosin Y	0.4 g
Methylene Blue	0.065 g
Distilled Water	1000.0 ml

36 grams of ingredients are suspended in 1000.0 ml distilled water. The medium is boiled to dissolve completely. Final pH should be 7.2 ± 0.2.

Medium is dispensed and sterilised at 121^{0}C dor 15 minutes, and then it is cooled to 50 ^{0}C. Sterilised medium is dispensed into petri dishes for streaking of cultures [54].

EMB Agar is a differential plating medium, used for the isolation and differentiation of gram-negative enteric bacilli. Besides, it is suitable for streak inoculation of cultures in completed test. On EMB agar, coliforms produce small colonies with dark centers.

5.1.3 Solutions

5.1.3.1 Solutions for Measurement of BOD

Used solutions for measurement of BOD and their preparations are as follows:

a. Phosphate buffer solution pH 7.2 : 8,5 g KH_2PO_4 + 21,75 g K_2HPO_4 + 32,4 g $N_2HPO_3.7H_2O$ + 1,7 g NH_4Cl in 1 L

b. Magnesium sulfate solution : 22,5g Mg SO_3. 7 H_2O in 1 L

c. Calcium chloride solution : 27,5 g $CaCl_2$ in 1 L

d. Ferric chloride solution : $FeCl_2$. $6H_2O$ in 1 L

e. Acid solution : 28 ml conc. H_2SO_4 in 1 L

f. Alkali solution : 40 g NaOH in 1 L

g. Sodium sulfide solution : 1,575 g $Na_2S_2O_3$ in 1 L

h. Nitrification inhibitor : 2-chloro-6-TCMP

i. Glucose-glutamic acid solution : 150 mg glucose + 150mg glutamic acid in 1 L

j. Ammonium chloride solution : 1,15 g NH_4Cl in 1 L, pH 7,2

5.1.3.2 Solutions for Measurement of COD

Used solutions for measurement of COD and their preparations are as follows:

a) Standard potassium dichromate solution: 12,26 g $K_2Cr_2O_7$ in 1 L

b) Sulphuric acid reagent : 4,5 g $AgSO_4$ / kg H_2SO_4

c) Sulphuric acid : 220ml conc. H_2SO_4 in 1 ml

d) Ferroin indicator solution : 1,5 g 1,10-($C_{32}H_8N_2 .H_2O$) + 0,7 g $FeSO_3. 7H_2O$ in 1 L

e) Standard FAS : 98g Fe $(NH_4)_2(SO_4)_2 . 6H_2O$ + 20 ml conc. H_2SO_4 in 1 L

f) Mercuric sulphate : 0,4 g Hg_2SO_4

g) KHP Standard : 425mg $C_8H_5O_4K$ in 1 L

5.1.4. Equipment for Measurement of pH and Temperature

Special equipment for pH measurement are electronic pH-meter, glass electrodes, reference electrode silver, silver chloride, and magnetic stirrer [34].

Normally temperature value is measured by Celsius thermometers, which contain mercury. Thermometers must contain divisions at least 0,1 ^{0}C and they must reach constant temperature in short period [34].

5.1.5. Glassware.

Used glassware for our works are given below:

Dark coloured bottles (covered) are used in sampling for the measurement of total and fecal coliform numbers.

Flasks and erlenes are used for preparing and dispensing media. Test tubes are used as a container for liquid media. Durham tubes are used for the observing of gas formation if microorganisms are reproduced. Graduated pipettes are used for dispensing media into test tubes and inoculation of water samples into media. Petri dishes are used as container of media in completed test of total and fecal coliform organisms.

BOD bottles are used for measurement of BOD and COD values.

5.2 METHOD

5.2.1. Sampling

Samples were collected from certain stations of B.ÇEKMECE Lake. This process was occurred periodically for each month between 20.01.1999 and 20.12.1999 for a year.

Samples were collected from BÇ-1, BÇ-2, BÇ-3 and BÇ-4 sites of B.Çekmece Lake. This process was occurred according to Fahrettin Gücin's caution. For measuring of the parameters amount of the samples are 1000,0 ml. Sterilised equipment were used for sampling. BOD and COD samples were taken by plastic containers. Temperature and pH were measured immediately sampling locations. BOD, COD, total and fecal coliforms were measured at the laboratory as soon as possible quickly [54]

5.2.2. Measurement of BOD

Desired volume of water is placed into clean 5L-graduated cylinder with 4ml of each phosphate buffer, $MgSO_4$, $CaCl_2$, $FeCl_3$ solutions and 40-mg TCMP as nitrification inhibitor. The partially filled graduated cylinder is shook several times for saturation with DO and diluted to 4L. It is not seeded since samples had enough microorganisms samples are mixed at different ratios with this dilution water regarding to. After preparations of two BOD bottles, one of them is rapidly determined for initial DO. The second bottle is closed tightly, water sealed and incubated for 5 days at $20^0C \pm 1$. After 5-day incubation the final DO is determined for the second bottle. The difference between initial DO and final DO gives the BOD_5. For blank the difference should not be more than 0.2mg/l and preferably not more than 0.1mg/l [42].

5.2.3. Measurement of COD

Samples are collected in glass bottles. The measurement is going to be unstable, if there is a postponement. After a postponement the samples are preserved by acidification to $pH \leq 2$ using concentrated H_2SO_4 by pH-meter.

In a 250ml round bottom flask made of heat-resistant glass including 10ml sample 0,4g $HgSO_4$, several glass beads and 5ml of 0,25M $K_2Cr_2O_7$ solution are mixed. Then 15ml of sulphuric acid reagent is added slowly with swirling motion into the flask, which is in an ice-

bath. After that is the flask to a 12inch condenser connected. Care must be taken to assure that the contents of the flask are well mixed. If not, superheating may result and the mixture may be blown out of the open end of the condenser. After the attachment of the flask to the condenser the flask is applied to heat and refluxed for 2 hours at 148 ±3°C. The time required giving the maximum oxidation for a wastewater of constant or known composition may be determined and a shorter period of refluxing may be permissible. After boiling until formation of bubbles, the flask is allowed to call until 60°C about 30 minutes and the condenser is washed down. The acid solution is diluted to cool about room temperature. 2 or 5 drops of ferroin indicator are added to the solution and the excess dichromate is titrated with 0.025N ferrous ammonium sulphate (FAS) solution to the end point. The colour change is sharp, changing from a blue-green to a reddish-blue [44].

5.2.4. Measurement of Temperature

Thermometer is sticked in the lake water at sampling sites for 1-2 minutes and then temperature value is read and registered. [34].

5.2.5. Measurement of pH

Before using electrodes are washed with distilled water and cleaned with a salt paper. The equipment is standardised by helping buffer solutions. Solution is mixed continuously for homogenity. Temperature is measured before pH measurement. Temperature is regulated of the pH- meter, and the pH value is read. Before start to each measurement, electrodes must be washed again. If pH measurements, do in long periods, standardisation is need for each one [34].

5.2.6. Enumeration of Total Coliform.

Coliform bacteria are counted during water quality monitoring in two ways. The first of these is a more qualitative approach in which the most probable number (MPN) of cloakrooms is determined by the use of lactose or lauryl tryptose broth fermentation tubes. The second standard technique for measuring coliform density in water is the membrane filter technique (MF) [54].

In the multiple-tube (MT) method, a series of tubes containing a suitable broth culture medium is inoculated with test portions of a water sample.

Multi-tube (MT) method consists of presumptive test, confirmed test, and completed test.

In the presumtive test, dilutions from the water sample are added to lactose or lauryl tryptose broth fermentation tubes. After 24 to 48 hours of incubation at 35-37^{0}C, one looks for bacteria capable of fermenting of fermenting lactose with gas production, presumably coliforms. (The lauryl tryptose broth is selective for gram-negative bacteria due to the presence of lauryl sulfate).

In the confirmed test, one transfers material from the highest dilution of those lactose broth tubes that shwed growth and gas production into brilliant green lactose bile broth, which is selective and differential for coliforms.

In the completed test. a sample from the positive green lactose bile broth is streaked onto Levine's EMB or LES Endo agar and incubated for 18 to 24 hours at 35-37^{0}C. On EMB agar, coliforms produce small colonies with dark centers. On LES Endo agar, coliforms produce reddish colonies. Samples are then inoculated into brilliant green lactose bile broth and onto a nutrient agar slant. These tubes are incubated for 24 hours at 35-37^{0}C. If gas is produced in the lactose broth, and the isolated bacterium is a gram-negative (based on Gram stain) non-sporing rod, the completed test is positive.

The estimate of the number of coliforms (the most probable number) can also be done in the presumptive test. In this procedure, 15 lactose broth tubes are inoculated with the water sample. Five tubes receive 10 ml of water, 5 tubes receive 1 ml of water, and 5 tubes receive 0.1 ml of water. A count of the number tubes showing gas production is then and the figure is compared to a table developed by the American Public Health Association. The number is the most probable number (MPN) of coliforms per 100 ml of the water sample. (It should be noted that the MPN index usually comes from the presumptive test if raw sewage is being tested and comes from confirmed or completed tests for other types of samples) [55, 56].

5.2.7. Enumeration of Fecal Coliform.

Same procedures are used in fecal coliform procedure. Test tubes are incubated at 44^0C from 24 to 48 hours. After the incubation, according to formation of gas in Durham tubes, most probable numbers of fecal coliforms are enumerated from MPN tables [56].

6. RESULTS

6.1. General Evaluation of Physical, Chemical, and Biological Parameters.

Periodical changes of some parameters, measured at Istanbul Büyükçekmece lake are shown in the tables 6,7,8,9, and figures 2,3,4,5,6, and 7. When the results were examined in some of the parameters there were great diversities with respect months. If we do not take into consideration the fact that the wastes of Çatalca county with its 23 villages and Silivri county with its 4 villages were not subjected to any refinement, the results of those diversities will come out clear. Domestic and industrial wastes of here flow into the rivers, which feed the lake, rainfall, differing from month to month and other similar factors in different time and density. And with these rivers they fall into the lake. Increases and decreases observed in the results of measured parameters can arise from different characters of those wastes.

When all of the figures are examined, we can observe that variations of four sampling points' parameters suit each other. In other words, the water quality generally in the lake does not show great changes.

6.1.1. Physical and Chemical Parameters.

As we can see from tables 6,7,8,9, and figure 3, the chemical oxygen demand [COD) values show an increase from winter to summer months. And it reached its highest value in September. The reason of this increase in summer is the increasing concentration of organic substance as a result of decrease in the volume of water in the lake. In the water samples taken on the station at Tepecik (BÇ. 3), the chemical oxygen demand (COD) value in September was 48.0 mg/lt, in January it was found as 10.0 mg/lt.

As we can see from tables 6,7,8,9, and figure 4, the values of BOD_5 (except some exceptions) experienced an increase from winter to summer. In the water samples taken on the station at Tepecik BOD_5 value in January was 2.0 mg/lt, in August it was found as 12.0 mg/lt.

As we can see from tables 6,7,8,9, and figure 5, the pH values differed from month to month. In the water samples taken on the station at Tepecik pH values are between 7.25-8.50. In December the lowest value was 7.25, in March the highest value was measured as 8.50 mg/lt.

6.1.2. Bacteriological Parameters.

Total and fecal coliform values are shown in tables 6,7,8,9, and figures 6,7. In the samples taken from all of the stations total coliform number, during the first five and the last three months of the year, there occurred parallel increases and decreases. With some exceptions, in general there were obtained very different values. During the summer months in three stations, not to count Çakıldere (BÇ.2), the total number of coliforms increased in a great ratio.

In the number of fecal coliform values there were observed parallel increases and decreases. The most interesting point is that in February on all 4 stations there were obtained results very different from the other months. The increase in the amount of fecal coliforms in summer months as to compare with other months is much lower than that of February. The increases in the amount of fecal coliforms in February depended on the rainfall, arise from the wastes of farms in the region of the reservoir, wastes poured out in certain places, and canalization falls from the settlement centers in the surroundings.

In the samples taken from the station of Bahsayiş (BÇ.1) total coliform number in January was 170 MPN/100ml; in August 8760 MPN/100ml; the amount fecal coliforms in January was 2 MPN/100ml; in August 33 MPN/100ml. In the samples taken from the station of Çakıldere (BÇ.2) total coliform number in January was 280 MPN/100ml; in August 2880 MPN/100ml; the amount fecal coliforms in January was 3 MPN/100ml; in August 40 MPN/100ml. In the samples taken from the station of Tepecik (BÇ.3) total coliform number in January was 348 MPN/100ml; in August 14570 MPN/100ml; the amount fecal coliforms in January was 2 MPN/100ml; in August 29 MPN/100ml. In the samples taken from the station of Mezarlıkönü (BÇ.4) total coliform number in January was 220 MPN/100ml; in August 12000 MPN/100ml; the amount fecal coliforms in January was 2 MPN/100ml; in August was found as 43 MPN/100ml.

Table 6. Analysis- data of Samples from Bahsayiş (BÇ.1) site.

Parameters	01/20/99	02/20/99	03/20/99	04/20/99	05/20/99	06/20/99	07/20/99	08/20/99	09/20/99	10/20/99	11/20/99	12/20/99
Temperature (°C)	7.0	6.0	10.0	15.0	18.0	20.0	23.0	24.0	17.0	12.0	9.0	8.0
COD (mg/lt)	12.0	17.0	13.0	11.0	16.0	19.0	18.0	34.0	37.0	15.0	14.0	22.0
BOD_5 (mg/lt)	4.0	3.0	3.0	2.0	5.0	2.0	4.0	7.0	9.0	8.0	6.0	9.0
PH	8.10	7.95	8.30	8.23	7.80	8.10	8.25	8.15	8.40	7.65	7.45	7.70
Total Coliform (MPN/100ml)	170	350	280	860	380	3120	4980	8760	4480	2180	1600	570
Fecal Coliform (MPN/100ml)	2	230	24	4	7	13	22	33	20	0	0	16

Table 7. Analysis- data of Samples from Çakıldere (BÇ.2) site.

Parameters	01/20/99	02/20/99	03/20/99	04/20/99	05/20/99	06/20/99	07/20/99	08/20/99	09/20/99	10/20/99	11/20/99	12/20/99
Temperature (°C)	7.0	6.0	9.0	15.0	18.0	21.0	24.0	25.0	16.0	11.0	9.0	8.0
COD (mg/lt)	9.0	15.0	17.0	15.0	18.0	22.0	19.0	29.0	33.0	10.0	12.0	24.0
BOD_5 (mg/lt)	3.0	3.0	6.0	5.0	2.0	7.0	6.0	10.0	12.0	6.0	5.0	10.0
pH	7.84	7.90	8.10	8.20	7.70	8.40	8.30	8.25	8.14	7.80	7.50	7.90
Total Coliform (MPN/100ml)	280	448	520	660	345	2720	3440	2880	2160	1920	1600	880
Fecal Coliform (MPN/100ml)	3	200	16	3	3	20	30	40	4	0	0	21

Table 8. Analysis- data of Samples from Tepecik (BÇ.3) site.

Parameters	01/20/99	02/20/99	03/20/99	04/20/99	05/20/99	06/20/99	07/20/99	08/20/99	09/20/99	10/20/99	11/20/99	12/20/99
Temperature (°C)	8.0	6.0	10.0	16.0	19.0	21.0	24.0	24.0	17.0	10.0	9.0	8.0
COD (mg/lt)	10.0	18.0	15.0	17.0	20.0	18.0	24.0	32.0	48.0	21.0	13.0	15.0
BOD_5 (mg/lt)	2.0	5.0	4.0	4.0	5.0	6.0	3.0	12.0	10.0	3.0	3.0	2.0
PH	7.90	8.20	8.50	7.79	8.43	8.30	8.20	8.10	8.35	7.70	7.30	7.25
Total Coliform (MPN/100ml)	348	542	280	918	221	920	1600	14570	10000	2400	920	240
Fecal Coliform (MPN/100ml)	2	40	18	0	4	0	25	29	5	3	2	9

Table 9. Analysis- data of Samples from Mezarlıkönü (BÇ.4) site.

Parameters	01/20/99	02/20/99	03/20/99	04/20/99	05/20/99	06/20/99	07/20/99	08/20/99	09/20/99	10/20/99	11/20/99	12/20/99
Temperature (°C)	8.0	6.0	11.0	17.0	19.0	21.0	24.0	25.0	17.0	12.0	10.0	9.0
COD (mg/lt)	10.0	13.0	17.0	15.0	21.0	26.0	18.0	27.0	29.0	18.0	10.0	17.0
BOD_5 (mg/lt)	3.0	5.0	6.0	3.0	7.0	8.0	5.0	9.0	12.0	7.0	2.0	4.0
pH	8.18	8.40	8.44	7.60	8.29	8.16	8.27	8.33	8.57	7.80	7.40	7.30
Total Coliform (MPN/100ml)	220	920	540	660	350	1600	1620	12000	11550	1609	918	542
Fecal Coliform (MPN/100ml)	2	280	9	2	0	12	26	43	4	0	0	33

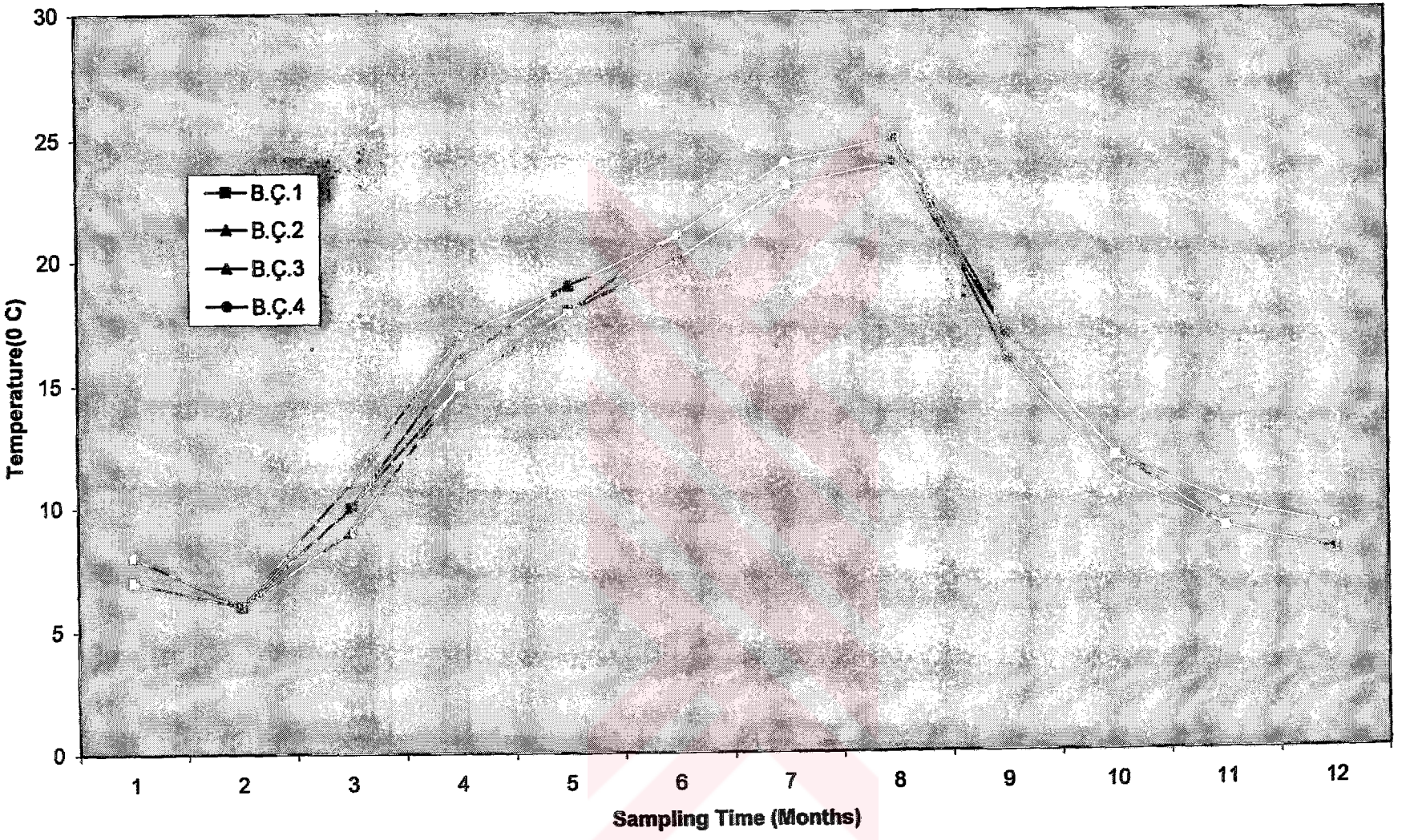

Figure 2. Changes of Temperature at B.Çekmece Lake

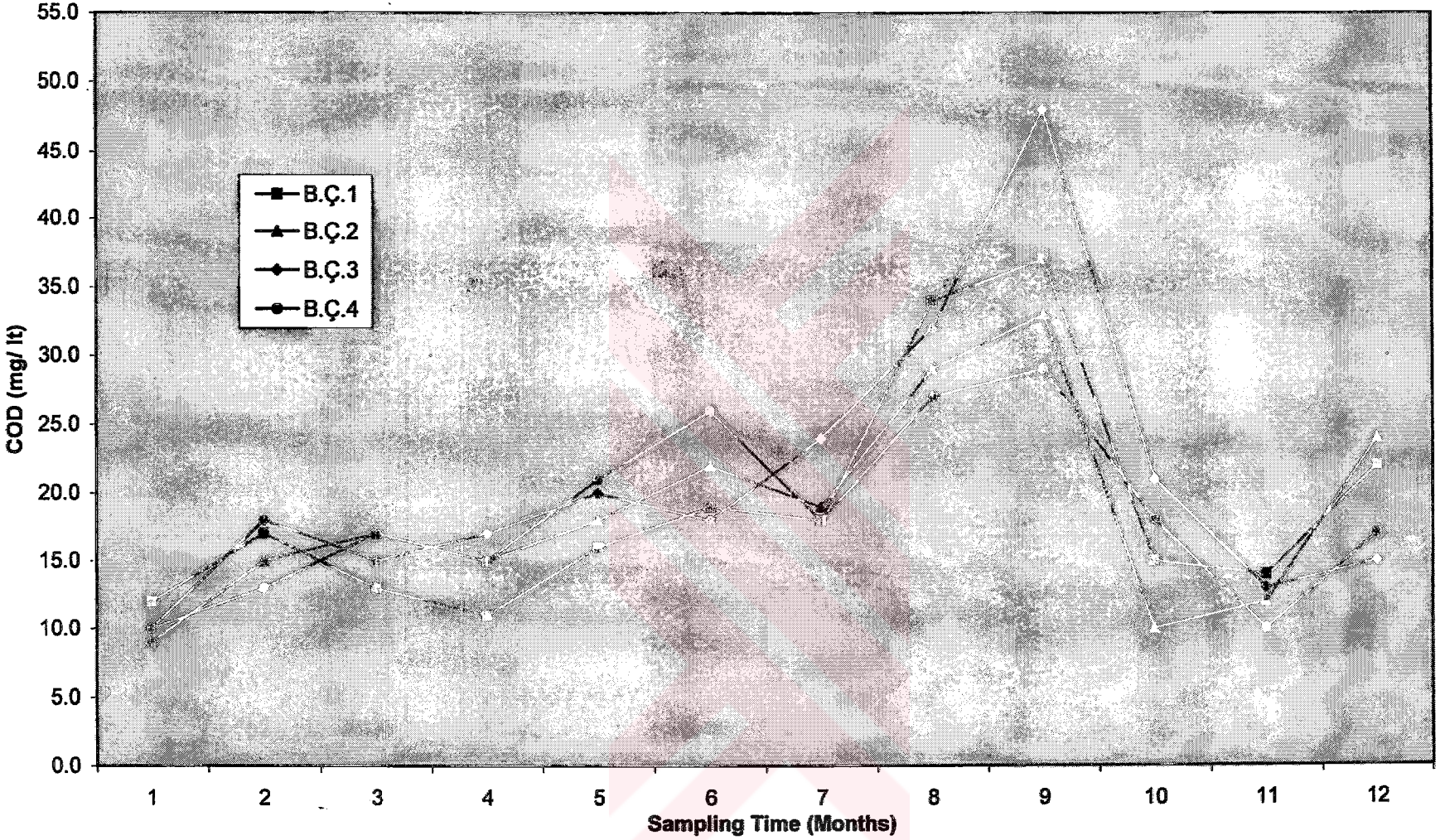

Figure 3. Changes of COD at B. Çekmece Lake

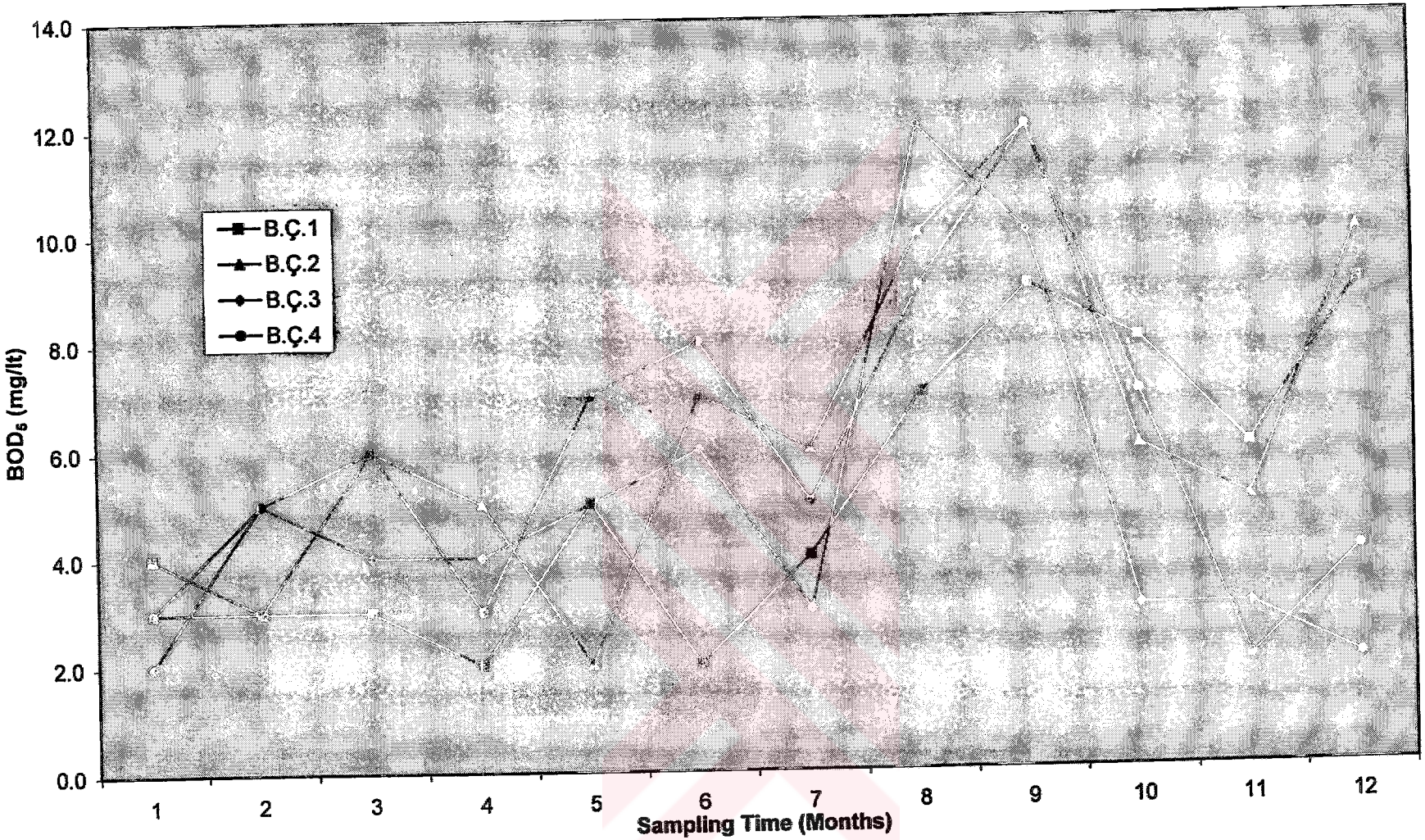

Figure 4. Changes of BOD_5 at B. Çekmece Lake

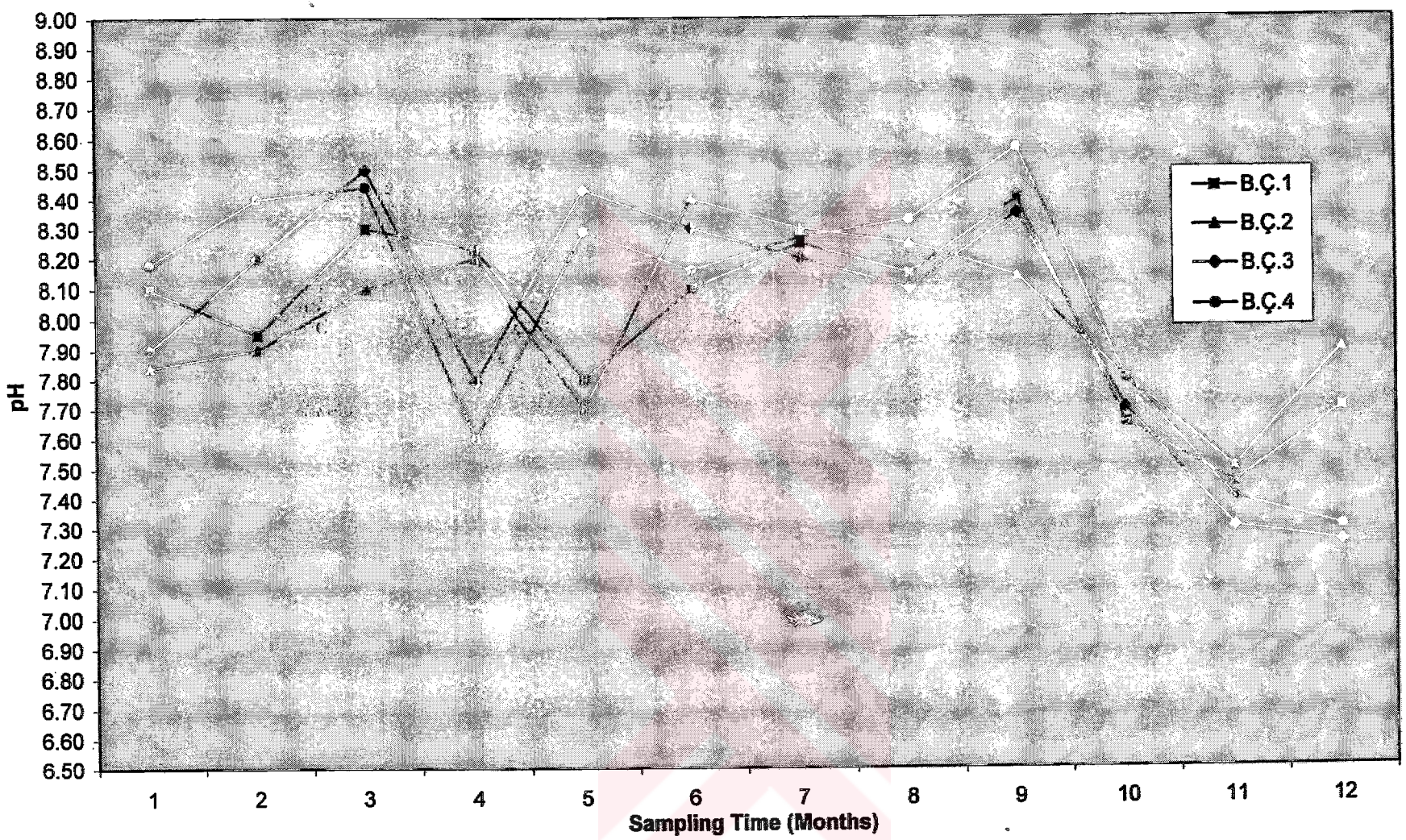

Figure 5. Changes of pH at B. Çekmece Lake

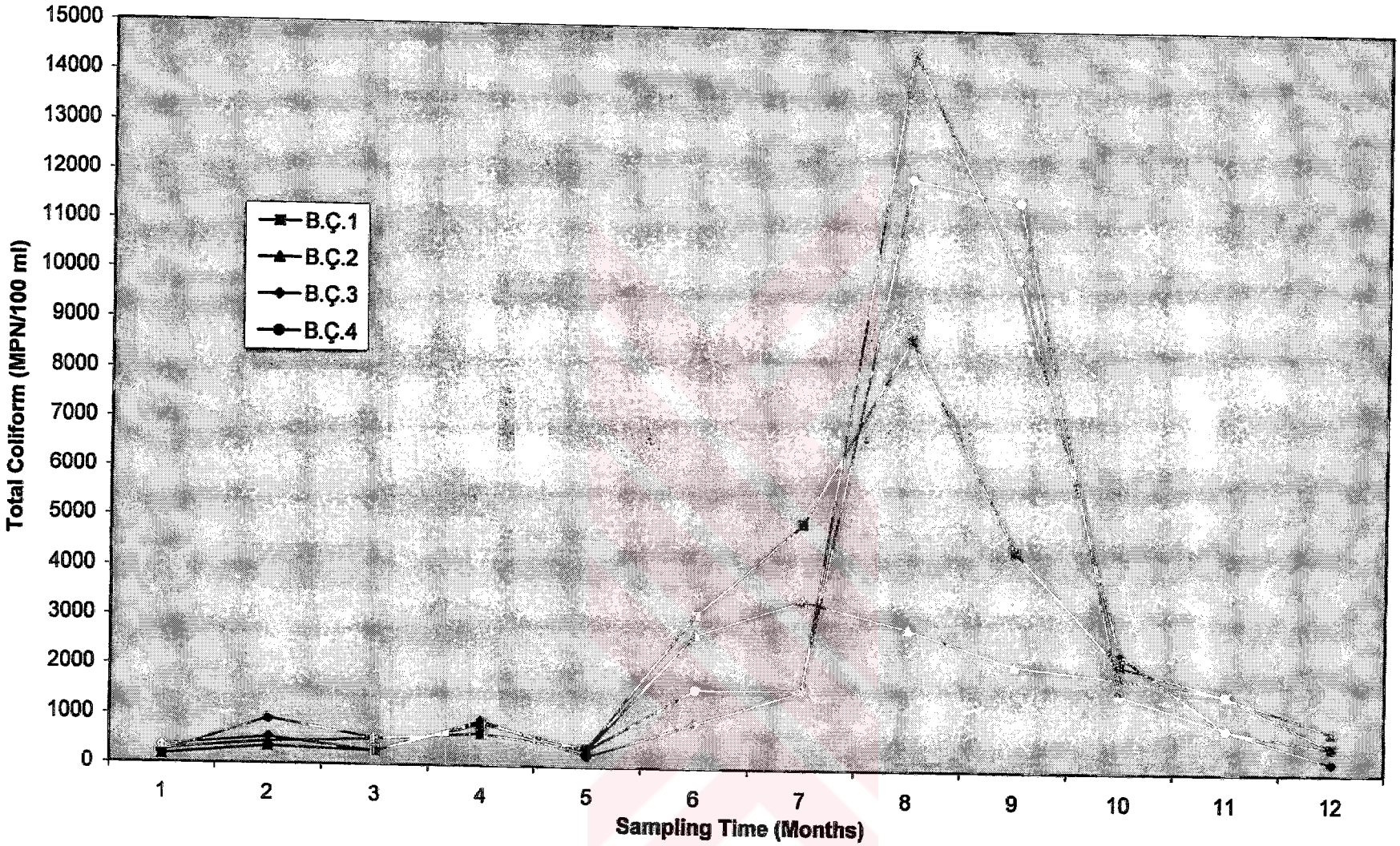

Figure 6. Changes of Total Coliform at B. Çekmece Lake

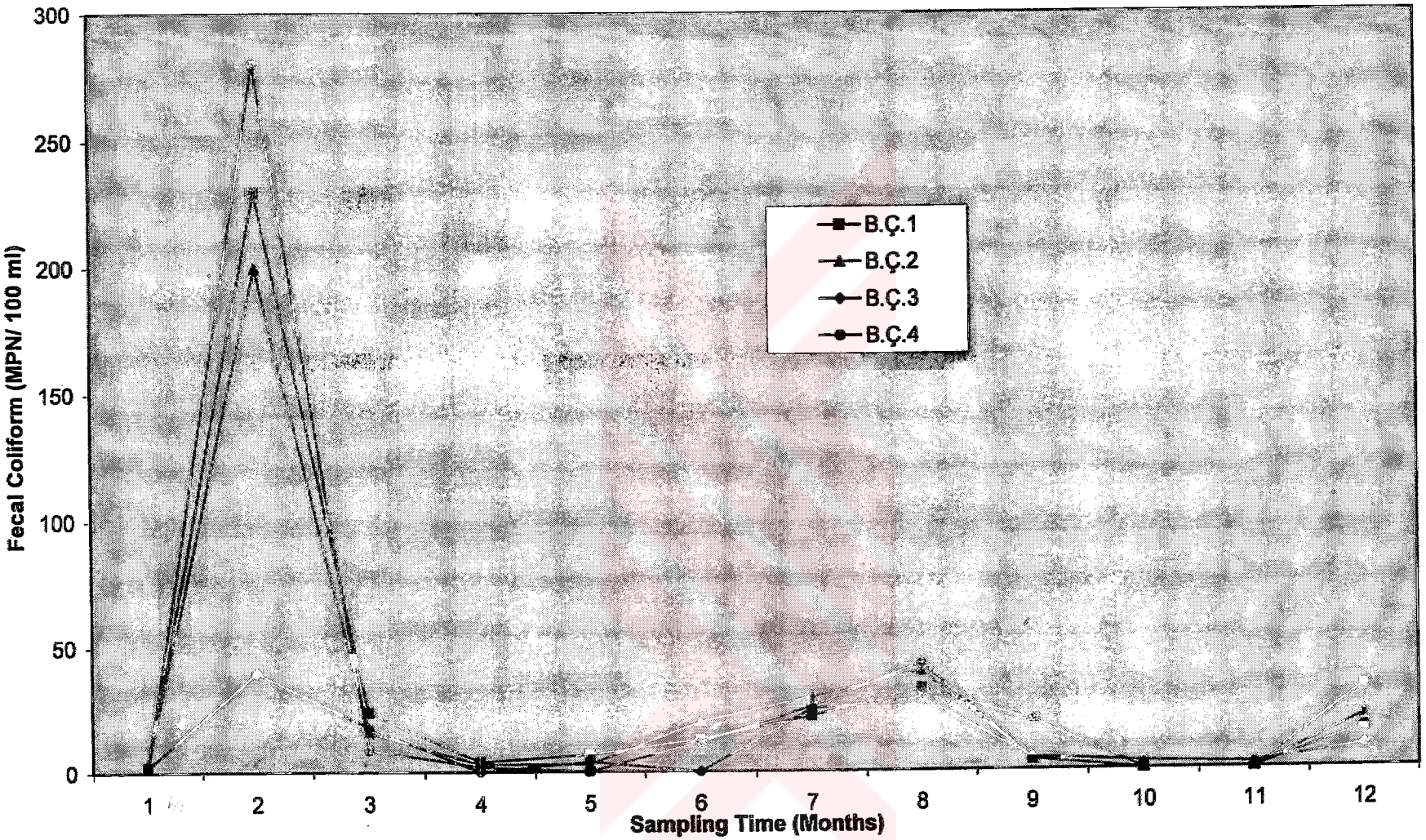

Figure 7. Changes of Fecal Coliform at B.Çekmece Lake

7. DISCUSSION

In Istanbul – a city with a population over than ten millions, the most important industrial and commercial center of Turkey, and a world city – providing drinking and tap water has been the cities one of the most important problems and it is clear that so it will be in the future. The importance of this problem is getting bigger and bigger parallelism with the growth of the city itself. The enlargement and growth of the city and industrialisation has increased both water demand and pollution in current water sources. In Istanbul the expansion of the city has reached up to water deposits, and even in same areas it has started to threaten protection areas. Büyükçekmece and Tepecik towns are typical sample for this point.

The water demand in a great part of Istanbul is supplied from the lake of Büyükçekmece. The lake is being polluted by house and industrial wastes from the surrounding settlement centers. Above this, the rivers feeding the lake bring with themselves organic polluters and heavy metals from these settlement centers. The opening for service, though late, of a refinement center by İSKİ to collect and clean the wastes from surrounding is, of course, a good improvement. The wastes, emptied from the surroundings because of the inexistence of canalisation of some of the settlement centers, are being fallen into the rivers by means of the rainfall and, thus, affect the pollution of the lake.

In the determination of water resources quality criteria some physical, chemical, and bacteriological parameters are used [36]. Throughout these parameters, COD and organic substances are determined with accordance to the amount of oxygen needed for the chemical stabilisation. The amount of the organic substance that can be oxidised is determined easily because it is rational to the amount of potassium dichromate [43, 57].

In the inland water resources, if the value of COD is less than 25 mg/lt, it is the first quality water; if more than 70 mg/lt, then it is defined as very polluted water [36]. In the study conducted by İSKİ (1988) on the station somewhere at Büyükçekmece lake, COD value 88 mg/lt exceeded the İSKİ crude standard of 50 mg/lt. In the samples taken from the front of the oil station at Tepecik village it approached the limit with 45 mg/lt. According to the samples taken by İSKİ, in 1999, from the refinement construction of the lake, COD values were found as <10.0 mg/lt in January, 15.0 mg/lt in February, 10.0 mg/lt in March, and <10.0

mg/lt in April. In our study the samples taken from Tepecik station have COD values 0f 18.0 mg/lt in January, 15.0 mg/lt in March, 20.0 mg/lt in May, 32.0 mg/lt in August, 48.0 mg/lt in September, and 15.0 mg/lt in December (Table 8 and Figure 3).

From winter to summer months the value of COD increased in general. This increase arised from the decrease of rainfall resulted in the increase in the amount organic substance in the lake. According to the results obtained, the level of COD in Büyükçekmece lake showed variations with respect to months, and, in general, the first class water is the position of the second class in some months.

BOD is the amount of oxygen spent by microorganisms during the metabolic activities in order to surtain their life cycles, grow, and reproduce [62]. The experiment determined the amount of oxygen in water, prepared and standardized it stociometrically to be able to convert into the amount of organic substance [63]. In the continental water resources, if the value of BOD_5 is more than 20 mg/lt, the resource is said to be very polluted [36]. In the study conducted by Boztepe in 1985, the average BOD_5 value in Seyhan river was found as 3.2 mg/lt [22]. In the studies conducted by Türkman in 1981, in the rivers flowing into Izmir gulf the value of BOD_5 was found to be more than 200 mg/lt [24]. In one year study conducted by Dülger in 1997, in Bursa Nilüfer river, the values of BOD_5 were determined to be higher in summer months. Besides, it was determined to be very polluted according to BOD_5 levels [30].

The values that below to the samples taken by İSKİ from the front of the lake refinement construction, show the average number of January, February, March, and April as 3.0 mg/lt. In our study, the BOD_5 measures of Tepecik (BÇ. 3) station were found as 2.0 mg/lt in January, 5.0 mg/lt in February, 4.0 mg/lt in March-April, 5.0 mg/lt in May, 6.0 mg/lt in June, 3.0 mg/lt in July, 12.0 mg/lt in August, 110.0 mg/lt in September, 3.0 mg/lt in October-November, 2.0 mg/lt in December (table 8 and figure 4). The results of BOD, in general, are parallel and experience in increase due to summer months. These increases arise from the decrease of water level relative to the rainfall amount. According to results, Büyükçekmece lake sometimes have the first, but sometimes also the second quality of water. This changes monthly.

By the pH determination we can identify either acidic or basic property of water. The standards do not require the values of pH higher or less than 6-9. If the values are out of standards, it show that the water is too polluted. In 1988, in a study of the directorate of the DSI XIX district, it was observed that the standards interval of pH of the lake was much dense on the basic side. In the monthly periodic measurements of İSKİ, made in 1999, only four months of the twelve had the pH between 5-7, in other eight months they always were between 5-8. In the study of ours, the values of Bahsayiş (BÇ.1) are between 7.45-8.40; those of Çakıldere (BÇ.2) are between 7.50-8.40; of Tepecik (BÇ.3) are between 7.25-8.50; of Mezarlıkönü (BÇ.4) are between 7.30-8.57. According to our results, the lake water exceeds the standards, though it shows basic characteristics.

If the most probable number of the coliform group bacteria, used as indicator organisms in bacteriological investigation of waters, is higher than 100.000 (MPN/100ml), the water resource is characterised as very polluted [36].

The bacteria included in the fecal coliform are used as indicator to determine fecal pollution in waters [52]. The most important of those bacteria are *E.coli, Citrobacter* sp., *Enterobacter* sp., *Klebsiella* sp., *Enterococcus faecalis, Entercoccus faecium, Entercoccus durans, Entercoccus equi, Clostridium perfingens, Bifidobacterium* sp., and *Pseodomonas aeruqinosa* [52]. The existence of indicator microorganisms shows that the water resources were polluted by men and warm-blooded animals [58]. The presence of certain amount of *Escherichia coli* and other coliform bacteria at the same medium is an indicator of presence of patogenic bacteria [59]. According to Metcalf, a man discharges about 100-400 billion coliform organisms and other bacteria types a day [60].

Fecal coliforms are facultative anaerobic bacteria, thus, enduring to temperature. Because the number of fecal coliforms is closely related to conditions of the medium, are found in different places in different numbers [35].

They studied upon the bacteriological pollution one year with periods in Vantaanjoky river flowing into Finland gulf. And they gained very diverse values about numbers of thermotolerant coliforms. It was informed that the numbers reached their low values in summer, high values in winter, and the highest values in spring and autumn. According to the investigations the reason of the out-coming low numbers in summer is the

sensibility of the coliform group organisms to sunlight. And the out-coming high numbers in winter is from the stable temperature of water under ice surface. The very high coliform numbers in spring and autumn are because of increasing flood constraints, suspense substances, and wastes emptied from the surroundings.

Kırımhan et al. observed monthly the water quality of Hazar lake in Elazığ between April and September, in 1992. In the end of the study, they pointed out that there was an increase in bacteriological contamination in summer seasons [29].

Samastı et al. examined Terkos lake and its brooks, and Büyükçekmece lake. They found out >1100 (MPN) coliform bacteria and in some samples there were intestinal *E.coli* [31].

Yıldız found out 100 % coliform bacteria, 25 % *E.coli* originated from intestine in Ömerli and Büyükçekmece lakes [32].

In the study conducted by us, the total coliform values of Bahsayiş (BÇ.1) are between 170-8760 (MPN/100ml), fecal coliform values are between 0-230 (MPN/100ml); total coliform values of Çakıldere (BÇ.2) are between 280-3440, fecal coliforms are 0-200 (MPN/100ml); the total coliform values of Tepecik (BÇ.3) are between 221-14570 (MPN/100ml), fecal coliform values are between 0-40 (MPN/100ml); the total coliform values of Mezarlıkönü (BÇ.4) are between220-12000 (MPN/100ml), fecal coliform values are between 0-280 (MPN/100ml) (tables 6,7,8,9, and figures 6,7).

The diversities observed in the results show that the reservoir of Büyükçekmece lake is not preserved good enough. The wastes of settlement centers and industrial costruction from the surrounding reservoir region, which do not have any canalisation, are being discharged into the lake through the rivers and rain streams. And, thus, the measures become very different by the influence of the surrounding factors. In summer months and September there were observed great increases in the total number of coliforms. This can be explained by the increase in rainfall and population of people, as a matter of tourists coming. The same factors resulted in the increased amount of fecal coliforms in summer months. The reasons for a very high increase of the amount of fecal coliforms in February were the wastes coming out from the farms and canalisation by rivers and rain streams. According to these obtained results, Büyükçekmece lake has the characteristics of the first and the second quality water.

The refinement construction being built by İSKİ will collect all the canalisation wastes and refined, when it opens for service. Thus, the pollution of the lake will be prevented in great ratio.

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