QUALITY CHARACTERIZATION OF WATER AND SOIL

Introduction:

The water resources have been most exploited natural system since man strode the earth. Pollution of water bodies is increasing steadily due to rapid population growth, industrial proliferations, urbanization, increasing living standards and wide spheres of human activities. Time is perhaps not too far when pure and clean water, particularly in densely populated industrialized water scare areas may be inadequate for maintaining the normal living standards (Patil, et al. 2003). The deterioration of the aesthetic life supporting qualities of natural lakes caused by excessive fertilization due to effluents, rich in NPK and organic substances. Various flora and fauna are affected and men themselves in counter face numerous serious problems in water system. Several natural impurities which come from atmosphere catchment areas and the soil are directly added to the water (Auti, 2002).

Water bodies in their natural state undergo changes in their physicochemical and biological characteristics. However, man’s interference by way of development activities in the catchment areas (e.g., deforestation, cultivation, construction activities, tourism, etc.) and disposal of effluents from housing, settlements and industries which shortens the span of these water bodies and lake get “old at younger age”. The change mostly leads to increased level of nutrients and organic matter and the resultant changes in flora and fauna of the water and the process of eutrophication, resulted changes in physicochemical and biological alternations (Sharma, 2000).

Focusing on drinking a domestic water supply in urban and rural areas, the urban population of India as per latest census 217.2 millions spread over 3768 urban agglomerations, this accounts for 25.7% of the total population of the country. As per population projections, it is expected that by 2011 and 2021, the urban population in the country may touch 410 million and 670 million
marks respectively, accounting for 35% and 50% of country’s total population in these coming years. The picture in the millennium will be beyond our imagination. Incase of rural sectors is on-sharing of available water between agriculture and drinking, the dependence is more on ground water where there is competition on exploitation leading to the depletion of the water pace with recharge and discharge to renew the balance. The quality of available water is also facing problem due to excess fertigation, poor solid waste management and increasing concentration of mineral salts in the deeper aquifers (Dara, 1993).

The main constraints that are faced are inadequate trained personnel, inability to mobilize internal and external resources, inadequate project preparation, uncoordinated development approach, institutional weakness, technological shortcomings, poor quality of water resources, water losses through leakage, intermittent services, hazard garbage collection and disposal systems, inadequate drainage of surface runoff, non-involvement of community in project planning, development, operation and maintenance activities, etc. There has a big problem of inherited quality of the main source especially with respect to good water sources. There has been decline of the available sources for two reasons, first, the source areas are being naturally degraded and the rate of annual increment is getting decreased. The second is due to the overexploitation from the agricultural sectors. In case of surface water sources, the lakes/tanks are getting silted due to the environmental degradation in their respective catchments. The storage capabilities are getting decreased year by year. The effluents allowed long contributing tributaries bringing the quality level below the standards (Dara, 1993).

India is blessed with unparalleled natural resources of rivers, reservoirs, estuaries, lakes, ponds and flood wetlands. Dams, naturally or manmade formed depressions filled with water, used for irrigation, power generation, fishery development and recreation.
Water is one of the most important natural resources for all the living organisms, whether unicellular or multicultural, since it is required for various metabolic activities. In addition, water is required for various domestic purposes, irrigation, shipping, power generation and industries. Natural waters are extremely varies in chemical composition and the factors controlling the composition includes physical, chemical and biological processes (Bhosle, 2001).

The Man’s influence on these water bodies caused rapid cutting of surrounding vegetation, thus increasing silt and nutrient load, disposal of sewage and industrial wastes, use for defecation, cultural activities, and agriculture around the water bodies using agrochemicals greatly increased the quantity of nutrients and organic input in to a water body. Thus, the water bodies started getting eutrophied at very early stage. In India a large number of studies on limnology of lentic water bodies have been carried out in past 30 years (Lakshminarayana 1963; Shardendu and Ambasht 1988; Pathak 1990; Pandey, et. al., 1993; Lohar and Patel, 1998; Shastri, 1999; Raghunathan, 2000; Kumar and Sharma, 2001; Bahura, 2001; Naga Prapurna and Shashikant, 2002; Jakher and Rawat, 2003; Nisar Shaaikh, 2004, Yardi et.al. 2005, Patil et.al., 2006) but there are few reports on gross pollution of fresh water dams. Natural water including rainwater always contains certain quantities of impurities including dissolved gases, inorganic and organic substances and suspended components. To repeat an off stated truism “Pure water does not occur in Nature” (Malathi, 1999).

The physico-chemical pollution of water brings about changes in water with regard to its colour, odour, density, turbidity, acidity, alkalinity, pH, dissolved oxygen, hardness, carbon dioxide, chlorides, sulphates, etc. Biological pollution is caused by the excretory products of worm-blooded animals and also brought about by viruses, diatoms like protozoa, rotifers, crustaceans and plant toxins (Malathi, 1999).
Physico-chemical parameters studied as abiotic components individually and collectively condition the diversity and biomass at given space and time. Further, these parameters exhibit diurnal and seasonal variations apart from variations resulting from geographical and climatic conditions. Due to its open nature continuous exchange of matter and energy goes on between the aquatic ecosystems and its environment apart from stress resulting from man made activities. In general, pollution invariably alters water quality, in turn, influencing bio-geochemical cycles, diversity, biomass and overall trophodynamics. Any change in the physico-chemical environment has direct influence on biotic communities due to the fact that different species of flora and fauna exhibit great variation in their responses to the altered environment (Wetzel, 1983).

The water quality of the river and reservoir varies from time-to-time and place-to-place, due to interaction of local factors. The river and dam water has been used for drinking, agriculture and industries etc. In the absence of any in-depth knowledge about the water quality and ill effects the inhabitants are prone to disease and health problems reported by Kulkarni et al., (1995), Salaskar and Yeragi (1997), Shastri, et al., (1999), Narasimha Rao and Jaya Raju (2001); Anitha (2000). Studies on hydrobiology of the fresh water lentic habitats about its physico-chemical characteristics and their productivity is well documented by Savant (1983), Subbamma and Rama Sarma (1992) and Pandey et al., (1993), Bahura (2001), Musaddiq et al., (2001). Few records are available on the nutrient composition (Phosphate and Nitrates) of the fresh water lakes or dams (Johnson, 1991a, 1991b) and ecological influence on phosphate in the fresh water tank. Bhalerao and Khan (2000) stated that fluorine and sulphur contents in the dam in tribal areas of Marathwada region.

The knowledge of Physico-chemical parameters along with biological characteristics provides clear idea of the trophic status of water body. Several workers like (Sreenivasan, 1964b; Mathew 1975,
Shukla and Bais, 1990; Bias et al., 1993; Naga Prapurna and Shashikant, 2002) have studied the role of physico-chemical and biological characteristics in reservoirs and lakes.

Adwant (1981) stated that balancing of the aquatic ecosystem in stretch of river Godavari passing the Nanded city is grossly polluted by the factors like raw domestic sewage, industrial wastes and ash from cremation grounds thereby making the water unfit for domestic use.

Kant and Vohra (1989) have rightly suggested that the management of aquatic ecosystem essentially be aimed at conservation of fresh water habitats through maintenance of the water quality or by rehabilitating the physico-chemical and biological quality of water for environmental management and conservation. Biological assessment of water has specific advantage over the chemical assessment, it requires simple fieldwork, collection and study of flora and fauna in relation to prevailing physico-chemical environment (Kodarkar, 1994).

In an aquatic ecosystem, physico-chemical environment has profound influence on its biotic components as it controls diversity, biomass and spatial distribution of the matter in time and space. The physical and chemical parameters exert their influence both individually and collectively and their interaction produces abiotic environment which ultimately conditions the origin, development and finally succession of biotic communities (Arul, 2000).

Soil is one of the most significant ecological factors, which is developed by weathering of the rocks present in the nature and differentiated into different horizons having various heights and different characters. Soil is defined as “A complete physiological system providing water, mineral salts, nutrients, dissolved oxygen and anchorage to plants.” The soil is a natural medium for the plant growth and supplies the required nutrient material for their growth. The soil may remain fertile when it contains adequate amount of all essential elements in the form, which is readily available to plants.
The soil consists of the five major components viz.- mineral matter, organic matter, air, water and microorganisms (Dara, 2002).

Due to dumping of industrial wastewater, toxic substances leach and seep into soil and affect the soil quality. Presence of the toxic substances in the form of leachates leads in the reduction of soil fertility. Disposal of industrial waste is a major problem responsible for the soil pollution (Ugale, 2002). These industrial pollutants mainly discharged from the pulp and paper mills, chemical industries, textile industries, sugar factories, pharmaceutical industries etc. The industrial effluent mainly consists of the organic compounds along with inorganic compounds along with inorganic complexes and non-biodegradable material (Barica, 1981). This pollutant alters the chemical and biological properties of the soil. Agricultural fields in many countries are heavily affected by the discharge of effluents from industrial establishments to water bodies that are main sources of irrigation. Metallic contaminant viz., Hg, Pb, Zn, As, Cd, Cr, Na, K, Cu, etc. destroys bacteria and beneficial microorganisms in the soil. Heavy metals are considered to be an indestructible poisons and their accumulation in soil for a longer period may be highly fatal to living organisms (Patwari, 2002).

Sewage and industrial wastewater contains large amounts of salts, which may sometimes serve as nutrient for plants. Soils receiving industrial and domestic waste have a great capacity to absorb nutrients and act as efficient purifying media (Pandey et al., 1999).

Ponds, reservoirs, streams and well waters are also analyzed by some workers (Vasisht and Bandal, 1979; Mahadevan and Krishna Swamy 1984; Saha and Pandit, 1986; Zafar and Khan 1980; Bais and Agrawal, 1995; Yeol and Patil, 2005; Pawar and Mane, 2006). Chandra Prakash (1992) observed seasonal variations of certain chemical parameters in soil and water phases in a small pond along western India.
With rapidly advancing technology, man’s impact upon the world of natural resources is beginning to prove overwhelming. Rapid urbanization, with the consequent increase in population and building construction, has resulted in the reduction of lands for the wastes to be disposed. Every year solid wastes are increasing tremendously all over the world, depending upon the living standards of the people. Moreover, the garbage in the street corner bin spilled over sooner than it could be emptied. Several hazardous chemicals and the mountains of wastes are ultimately dumped on the lands (Sinha, 1986). Dumping of industrial and municipal wastes causes toxic substances to be leached and seep into the soil and affects the ground water course. Modern agricultural practices introduce numerous pesticides, fungicides, bactericides, insecticides, biocides, fertilizers and manures, resulting in severe biological and chemical contamination of land. Apart from all these, direct pollution of soil by deadly pathogenic organisms is also of major importance (Rao, 1975).

Soil characteristics are mainly distributed by Industrial and urban wastes, Radioactive substances, inadequate agricultural practices, Chemical and Metallic pollutants and certain biological agents. Urban wastes comprise both commercial and domestic wastes consisting of dried sludge of sewage. All the urban solid wastes are commonly referred to as ‘refuse’. This refuse contains garbage and rubbish materials like plastics, glasses, metallic cans, fibers, paper, rubbles, street sweepings, fuel residues, leaves, containers, abandoned vehicles and other discarded manufactured products (Veena et al., 1997).

It is estimated that in India alone, about 115 million of urban population produces nearly 15 million tones of solid wastes causing chronic pollution of land and water, it critically polluted cities like Bombay, Madras, Calcutta and Kanpur. Pollution concentration in urban areas and unplanned industrial progress in and around these urban areas, contributed to soil pollution in India. The waste
including building materials (during construction and demolition), sludge, dead animal skeletons and thrown away garbage pole up at public places and cause obstruction in daily life (Chandra, 2001).

Sewage is an excellent medium for the growth of pathogenic bacteria, viruses, and protozoa. Vibrio cholera found in sewage causes cholera, Shigella dysenteriae causes bacillary dysentery, while Salmonella typhosa spreads typhoid in man. Solid wastes result in offensive odour and cause clogging of ground water filters. Suspended matter in sewage can blanket the soil, thereby interfering with the soil moistures. The use of polluted ground water containing human excreta, sewage sludge i.e. solids from cess pools, detergents and trace metals for irrigating the agricultural fields damages crops and decreases agricultural production, together with soil fertility by killing bacteria and soil microorganisms (Dara, 1993).

The present study is aimed to investigate some of the important physical and chemical parameters of water and soil such as pH, alkalinity, Dissolved oxygen, Biological oxygen demand, Chemical oxygen Demand, hardness, chlorides, sulphate, phosphate and nitrate, sodium, Potassium etc. along with primary productivity of the Jaikwadi dam.
Material and Methods:

The water samples for physico-chemical analysis were collected from Jaikwadi dam at three different sites viz. a) South side of Jaikwadi Dam, b) Near water supply pump and C) Pimpalwadi side, between 8 am to 11 am weekly in every season. The samples were collected in acid washed plastic bottles from depth 5-10cms below the surface of water. Separate samples were collected for dissolved oxygen in 250 ml bottles. The dissolved oxygen in the BOD bottles was fixed at the field by adding alkaline iodide-azide solution immediately after collection.

The soil samples were collected from near water supply pump, Jaiwadi dam in polythene bags as per the standard methods suggested by Tivedy and Goel, (1986) and collected samples were brought to laboratory for further analysis. All the parameters were analysed by method APHA (1992) and Trivedy and Goel (1986). Soil suspension in distilled water (1:5) was allowed to stand for 30 minutes with occasional stirring. On return to the laboratory following methodology was employed for analysis of different physicochemical characteristics.

Primary productivity of the dam was determined in monsoon (June/July), winter (November/December) and in summer (March/April) (APHA, 1992; Trivedi and Goel, 1987; Strickland and Parsons, 1972). Measurement of primary production was done by using BOD bottles (light and dark) capacity of 300 ml. every fortnight water sample for the estimation of Gross productivity were collected from the surface and incubated for six hours. The gross primary productivity was calculated by finding the difference in light and dark bottles and expressed in mg/c/m³/day.
The water sampling sites of Physical and Chemical analysis is characterized as follows.

a] Site-I (S₁): (Fig; 1). Site I is located at “South site” of the Jaikwadi dam. The water collected at this site arises from Godavari river. This site is referred to as ‘symbol S₁’.

b] Site-II (S₂): (Fig; 2). Site II is located at “Near water supply pump” of Jaikwadi dam. The water collected at this site arises from Kham river. This site is referred to as ‘symbol S₂’.

c] Site-III (S₃): (Fig; 3). Site III is located at “Pimpalwadi site” of Jaikwadi dam. The water collected at this site arises from different tributaries (rivers). This site is referred to as ‘symbol S₃’.

Table: Methodology for physicochemical characteristics.

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<th>Parameters</th>
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<td>Winklers Azide</td>
<td>APHA, 1992</td>
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<td>Hardness</td>
<td>Titrometry</td>
<td>APHA, 1992</td>
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<td>Chlorides</td>
<td>Titrometry</td>
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<td>Titrometry</td>
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<td>C.O.D.</td>
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<td>Nitrate</td>
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<td>Sulphate</td>
<td>Phenol disulphonic acid Turbidometric</td>
<td>Trivedy and Goel,1986</td>
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Notes: D.O. = Dissolved Oxygen,  
B.O.D = Biochemical Oxygen Demand and  
C.O.D = Chemical Oxygen Demand
RESULTS

Temperature (°C):

Temperature of air and water was recorded by standard centigrade thermometer. It was observed that the temperature was lowered in water than air because of various reasons, like gases in air, humidity, dust and other colloidal particles. In water generally, in early hours of morning temperature is slightly warmer at surface. Seasonal variations in water temperatures values of different sites at Jaikwadi Dam are presented in table 1, 2 & 3 and graphically represented in Fig. 1.

In monsoon, during first year of study period (2004-05) water temperature was ranged between 27.76 ± 0.77 to 30.83 ± 2.08°C at south site (S 1). The minimum level of temperature was recorded in September but it in June it was reported to be at maximum level, while at near water supply pump (S 2) temperature was ranged between 28.33 ± 0.76 to 30.76 ± 0.92°C. The lower level of temperature was observed in July but in June it was recorded to at higher level, whereas at Pimpalwadi site (S 3) the temperature was ranged from 25.43 ± 1.25°C to 27.96 ± 0.55°C. The minimum temperature was recorded in July and maximum temperature was reported in September. During the second year study period of (2005-06) water temperature was ranged between 26.23 ± 1.06 to 28.00 ± 0.50°C. The minimum temperature was recorded in September and maximum temperature was reported in August at south site (S 1), while at near water supply pump (S 2), it was ranged between 29.16 ± 0.28 to 31.00 ± 1.03°C. The lower level of temperature was observed in September but in August it was reported to be at higher temperature, whereas at Pimpalwadi site (S 3) temperature was ranged from 30.30 ± 0.26 to 30.93 ± 0.8°C. The lower level of water temperature was recorded in July but in June it was reported to be at higher level.
In winter, during study period of (2004-05) the water temperature was ranged between 24.80 ± 0.72 to 25.73 ± 0.75°C at south site (S₁). The minimum level of temperature was recorded in January but in December it was reported to be at maximum level, while at near water supply pump (S₂), the water temperature was ranged between 25.26 ± 0.25°C to 31.33 ± 1.05°C. The lower level of temperature was observed in November and higher level of water temperature was recorded in January, whereas at Pimpalwadi site (S₃) the temperature was ranged between 24.33 ± 0.28°C to 25.86 ± 0.80°C. The minimum level of temperature was found in December but in November it was reported to be maximum level. During second year of study period (2005-06) the water temperature was ranged between 25.13 ± 0.51 to 26.16 ± 1.04°C. The minimum level of temperature was recorded in December and maximum level was reported in January at south site (S₁), while at near water supply pump (S₂) the temperature was ranged between 24.83 ± 0.85°C to 30.56 ± 0.40°C. The minimum value was observed in November and maximum temperature was reported in January, whereas at Pimpalwadi site (S₃) it was recorded in range between 27.43 ± 0.57 to 31.60 ± 1.31°C. The lower level of water temperature was recorded in December but in October it was reported to be at higher level.

In summer, during first year of study period (2004-05) the water temperature was ranged between 26.50 ± 0.86 to 31.83 ± 1.75°C at south site (S₁). The minimum level of temperature was recorded in February and maximum level of temperature was reported in April, while at near water supply pump (S₂) the water temperature was ranged between 32.33 ± 1.14 to 35.33 ± 0.97°C. The minimum level of temperature was observed in February and maximum level of temperature was reported in May, whereas at Pimpalwadi site (S₃) the temperature was ranged between 25.50 ± 0.50 to 31.34 ± 1.32°C. The lower level of temperature was recorded in February and higher level was reported in May. During the second year of study period (2005-06) the level of water temperature was
ranged between 26.30 ± 0.26 to 31.33 ± 1.25°C. The minimum level was recorded in February and maximum level of water temperature was recorded in May at south site (S1), while at near water supply pump (S2) the water temperature was ranged between 30.33 ± 0.92 to 33.13 ± 0.55°C. The lower level of temperature was observed in April but in March it was reported to be higher level, whereas at Pimpalwadi site (S3) it was ranged from 31.50 ± 1.32 to 33.40 ± 2.25°C. The lowest level of temperature was recorded in February while highest level in April.

In the present study period of (2004-05) the lower level of temperature was recorded in winter at Pimpalwadi site (S3) and the higher level of water temperature was reported in summer at near water supply pump (S2) while in second year of study period (2005-06) the minimum level of temperature was reported in winter at south site (S2) and maximum level of temperature was recorded in summer at near water supply pump (S3).

**pH:**

pH values are expressed as the negative logarithm of hydrogen ion concentration. For acidic water, pH varies for 0 to 7 and for alkaline water it varies from 7-14. Rain is the purest source of water and has pH of 7. Acid rain has pH<5.6 killed several tens of thousands of water bodies. On the field pH is recorded by pH stick/pH papers in the lab with the help of pH meter. Seasonal variations in pH values at different sites of Jaikwadi Dam are presented in table 4, 5 & 6 and graphically represented in Fig. 2.

In monsoon, during first year of study period (2004-05) the water pH was ranged between 7.53 ± 0.35 to 8.36 ± 0.20 at south site (S1). The minimum level of pH was recorded in June and maximum level was recorded in July. While at near water supply pump (S2) the pH level was in ranged between 7.43 ± 0.30 to 8.10 ± 0.10. The lower level of pH was observed in August and higher level was recorded in September, whereas at Pimpalwadi site (S3) the water pH was ranged between 6.03 ± 0.05 to 8.90 ± 0.40. The
minimum level of pH was recorded in August and maximum level pH was found in September. During the second year of study period (2005-06) the pH level was ranged between 7.30 ± 0.15 to 8.20 ± 0.20. The lowest level of pH was recorded in August and highest level of pH was reported in September at south site (S₁), while at near water supply pump (S₂) the pH level was ranged between 7.50±0.36 to 8.16±0.15. The minimum level of pH was observed in June and maximum level of pH was observed in August, whereas at Pimpalwadi site (S₃) it was ranged between 7.53 ± 0.25 to 8.16 ± 0.20. The lower level of pH was recorded in June and higher level was reported in September.

In winter, during first year of study period (2004-05) the pH level of water was ranged between 7.26 ± 0.30 to 7.60 ± 0.17 at south site (S₁). The minimum level of pH was reported in January but in December it was recorded to be at maximum level while at near water supply pump (S₂) the pH level was ranged between 7.53 ± 0.35 to 8.23 ± 0.15. The lowest value was reported in January and the highest level of pH was reported in November, whereas at Pimpalwadi site (S₃) it was ranged between to 7.90 ± 0.40 to 8.16 ± 0.20. The minimum level of pH was recorded in October while maximum level of pH was reported in January. During second year (2005-06) the pH level was ranged between 7.55 ± 0.38 to 8.26 ± 0.25. The lowest level of pH was recorded in November but in October it was reported to be at highest level at south site (S₁), while at near water supply pump (S₂) the pH level was ranged between 7.30 ± 0.26 to 7.36 ± 0.20. The minimum level of pH was observed in December and maximum level of pH was reported in January, whereas at Pimpalwadi site (S₃) pH was ranged between 8.86 ± 0.32 to 8.40 ± 0.40. The lower level of pH was recorded in October but in January it was reported to be at higher level.

In summer, during first year of study period (2004-05) the water pH was ranged between 7.76 ± 0.15 to 8.23 ± 0.05 at south site (S₁). The minimum level of pH was recorded in February and
maximum level was recorded in March. While at near water supply pump ($S_2$) the pH level was in ranged between $7.70 \pm 0.10$ to $8.26 \pm 0.20$. The lower level of pH was observed in April and higher level was recorded in May, whereas at Pimpalwadi site ($S_3$) the water pH was ranged between $7.90 \pm 0.40$ to $8.26 \pm 0.15$. The minimum level of pH was recorded in March and maximum level pH was found in May. During the second year of study period study period (2005-06) the pH level was ranged between $7.43 \pm 0.05$ to $8.30 \pm 0.30$. The lowest level of pH was recorded in April and highest level of pH was reported in May at south site ($S_1$), while at near water supply pump ($S_2$) the pH level was ranged between $7.86 \pm 0.32$ to $8.40 \pm 0.40$. The minimum level of pH was observed in February and maximum level of pH was observed in May, whereas at Pimpalwadi site ($S_3$) it was ranged between $7.30 \pm 0.26$ to $8.10 \pm 0.30$. The lower level of pH was recorded in February and higher level was reported in May.

During the study period of (2004-05), the pH level was lower in winter at south site ($S_1$) and it was recorded higher level in monsoon at Pimpalwadi site ($S_3$). While in second year of study period (2005-06) the minimum level of pH was recorded in winter at near water supply pump ($S_2$) and maximum level of pH was reported in summer at Pimpalwadi site ($S_3$).

**Electrical Conductivity [EC] (µ mhos/cm):**

The conductivity of a sample is a numerical expression of its ability to carry on electric current, which in turn depends on ionizable solutes and substances dissolved in it. On field it can be measured with help of conductive meter. Seasonal variations in conductivity values of different sites at Jaikwadi Dam are presented in table 7, 8 & 9 and graphically represented in Fig. 3.

In monsoon, during first year of study period (2004-2005) the EC level of water was ranged between $222.33 \pm 2.08$ to $273.00 \pm 0.73$ at south site ($S_1$). The minimum level of EC was reported in June and maximum level of EC was reported in August while at near water supply pump ($S_2$) the EC level was ranged between $489.66 \pm 4.16$ to
539.00 ± 6.16. The lowest value was reported in September but in August it was reported to be at highest level, whereas at Pimpalwadi site (S3) it was ranged between 213.33 ± 4.16 to 243.33 ± 2.88. The minimum level of pH was recorded in June while maximum level of EC was reported in August. During second year (2005-06) the EC level was ranged between 202.33 ± 4.04 to 240.00 ± 8.00. The lowest level of EC was recorded in August but in July it was reported to be at highest level at south site (S1), while at near water supply pump (S2) the EC level was ranged between 492.00 ± 12.49 to 554.66 ± 4.16. The minimum level of EC was observed in September but in August it was reported to be at maximum, whereas at Pimpalwadi site (S3) EC was ranged between 224.66 ± 4.06 to 249.66 ± 13.79. The lower level of EC was recorded in June and higher level was reported in August.

In winter, during first year of study period (2004-05) the water EC was ranged between 214.60 ± 5.50 to 244.00 ± 3.60 at south site (S1). The minimum level of EC was recorded in October and maximum level was recorded in January. While at near water supply pump (S2) the EC level was in ranged between 502.00 ± 8.00 to 678.33 ± 5.50. The lower level of pH was observed in October and higher level was recorded in January, whereas at Pimpalwadi site (S3) the level EC of was ranged between 201.00 ± 5.56 to 282.33 ± 1.04. The minimum level of EC was recorded in November and maximum level EC was found in January. During the second year of study period study period (2005-06) the EC level was ranged between 226.00 ± 2.00 to 239.33 ± 6.97. The lowest level of EC was recorded in January but in November it was reported to be at highest level at south site (S1), while at near water supply pump (S2) the EC level was ranged between 502.33 ± 531.66 ± 7.66. The minimum level of EC was observed in December and in October it was reported to at maximum level, whereas at Pimpalwadi site (S3) it was ranged between 204.00 ± 8.00 to 235.00 ± 9.03. The lower level of EC was
recorded in December but in October it was reported to be at higher level.

In summer, during first year of study period (2004-05) the water EC was ranged between 183.33 ± 4.16 to 121.66 ± 1.75 at south site (S1). The minimum level of EC was recorded in February and maximum level was recorded in May. While at near water supply pump (S2) the EC level was in ranged between 384.66 ± 8.14 to 577.00 ± 7.54. The lower level of EC was observed in May but in February it was reported to be at higher level, whereas at Pimpalwadi site (S3) the EC was ranged between 213.60 ± 1.20 to 294.66 ± 2.42. The minimum level of EC was recorded in March and maximum level EC was found in May. During the second year of study period study period (2005-06) the EC level was ranged between 202.33 ± 2.52 TO 276.66 ± 5.77. The lowest level of EC was recorded in April but in March it was reported to be at highest at south site (S1), while at near water supply pump (S2) the EC level was ranged between 418.00 ± 6.55 to 510.33 ± 7.63. The minimum level of EC was observed in April but in February it was reported to at maximum level, whereas at Pimpalwadi site (S3) it was ranged between 211.66 ± 1.52 to 274.33 ± 57.29. The lower level of EC was recorded in April but in February it was reported to be at higher level.

In the present study period of (2004-05), the EC level was lower in summer at south site (S1) and higher level of EC was recorded in winter at near water supply pump (S2). While in second year of study period (2005-06) the minimum level of EC was reported in winter at Pimpalwadi site (S3) and maximum level of EC was recorded in monsoon at near water supply pump (S2).

**Alkalinity (mg/lit):**

Seasonal variations in alkalinity at different sites of Jaikwadi Dam are presented in table 10, 11 & 12 and graphically represented in Fig. 4.

In monsoon, during the first year of study period (2004-05) the alkalinity value was ranged between 305.13 ± 3.00 to 512.00 ± 2.00
at south site ($S_1$). The lowest value of alkalinity was recorded in September but in August it was recorded to be at highest level while at near water supply pump ($S_2$) the alkalinity was ranged between 450.00 ± 122.90 to 506.66 ± 40.61. The minimum value of alkalinity was recorded in September but in August it was reported to be maximum value, whereas at Pimpalwadi site ($S_3$) the alkalinity of water was ranged between 442.20 ± 122.7 to 508.06 ± 8.60. The lower level of alkalinity was recorded in September but in August it was reported to be higher level. During the second year of study period (2005-06) the alkalinity level in water was ranged between 457.50 ± 5.00 to 506.06 ± 0.16 at south site ($S_1$). The lower level of alkalinity was recorded in June and higher level of alkalinity was recorded in August, while at near water supply pump ($S_2$) the alkalinity level was ranged between 505.3 ± 24.68 to 545.33 ± 28.93. The minimum level of alkalinity was recorded in June but in August it was reported to be maximum level, whereas at Pimpalwadi site ($S_3$) the alkalinity level was ranged between 514.33 ± 10.69 to 540.73 ± 36.88. The lower level of alkalinity was recorded in June and higher level of alkalinity was reported in August.

In winter, during the first year of study period (2004-05) the alkalinity value was ranged between 324.16 ± 16.15 to 331.7.73 ± 0.61 at south site ($S_1$). The lowest level of alkalinity was recorded in January but in October it was reported to be at highest level while at near water supply pump ($S_2$) the alkalinity was ranged between 4.59.66 ± 127.88 to 525.00 ± 158.48. The minimum value of alkalinity was recorded in November and maximum level of alkalinity was reported in January, whereas at Pimpalwadi site ($S_3$) the alkalinity of water was ranged between 461.33 ± 112.00 to 495.33 ± 160.17. The lower level of alkalinity was recorded in October and higher level of alkalinity was recorded in January. During the second year of study period (2005-06) the alkalinity level in water was ranged between 451.60 ± 78.00 to 481.50 ± 84.00 at south site ($S_1$). The lower level of alkalinity was recorded in December but in
November it was reported to be at higher level, while at near water supply pump (S_2) the alkalinity level was ranged between 512.33 ± 15.37 to 540.66 ± 80.92. The minimum level of alkalinity was recorded in October and maximum level was reported in January, whereas at Pimpalwadi site (S_3) the alkalinity level was ranged between 476.33 ± 62.58 to 504.66 ± 23.69. The lower level of alkalinity was recorded in October and higher level of alkalinity was reported in January.

In summer, during first year of study period (2004-05) the alkalinity level was ranged between 470.50 ± 32.40 to 545.50 ± 07.08 at south site (S_1). The minimum level of alkalinity was recorded in February and maximum level was recorded in March. While at near water supply pump (S_2) the alkalinity level was in ranged between 545.80 ± 33.63 to 578.80 ± 33.63. The lower level of alkalinity was observed in March and higher level was recorded in April, whereas at Pimpalwadi site (S_3) the level alkalinity was ranged between 501.0 ± 1.00 to 574.33 ± 29.67. The minimum level of alkalinity was recorded in May but in March it was reported to be at maximum level. During the second year of study period study period (2005-06) the alkalinity level was ranged between 471.96 ± 120.36 to 503.00 ± 26.40. The lowest level of alkalinity was recorded in April and highest level of alkalinity was reported in May at south site (S_1), while at near water supply pump (S_2) the alkalinity level was ranged between 536.66 ± 26.31 to 550.66 ± 77.59. The minimum level of alkalinity was observed in April but in February it was reported to be at maximum level, whereas at Pimpalwadi site (S_3) it was ranged between 516.00 ± 18.33 to 548.33 ± 42.21. The lower level of alkalinity was recorded in February and higher level of alkalinity was reported in May.

During the present study period of (2004-05), the lower level of alkalinity was recorded in winter at south site (S_1) and higher level of alkalinity was reported in summer at Pimpalwadi site (S_3). While in second year of study period (2005-06) the minimum level of alkalinity
was reported in winter at Pimpalwadi site (S$_3$) and maximum level of alkalinity was recorded in winter at south site (S$_1$).

**Hardness (mg/l):**

In monsoon, during first year of study period (2004-05) the hardness of water was ranged between 101.00 ± 4.58 to 204.00 ± 4.00 at south site (S$_1$). The minimum value of hardness was recorded in June and maximum value was reported in September, while at near water supply pump (S$_2$) the harness was in ranged between 105.66 ± 4.41 to 196.66 ± 15.94. The lower value of harness was observed in June and higher value was reported in September, whereas at Pimpalwadi site (S$_3$) it was ranged between 88.00 ± 8.71 to 226.00 ± 15.39. The minimum value of hardness was recorded in June and maximum value was reported in September. During the second year of study period (2005-06) the water hardness was ranged between 105.66 ± 4.41 to 194.66 ± 13.65. The minimum hardness was recorded in June while maximum hardness was reported in September at south site (S$_1$), while at near water supply pump it was ranged between 109.00 ± 6.55 to 216.00 ± 5.29. The minimum level of hardness was observed in June and maximum level was reported in September, whereas at Pimpalwadi site (S$_3$) it was ranged from 93.66 ± 4.50 to 224.33 ± 5.50. The lower level of hardness was recorded in June and higher level was reported in September.

In winter, during first year of study period (2004-05) the hardness of water was ranged between 224.33 ± 4.93 to 266.33 ± 1.52 at south site (S$_1$). The minimum value of hardness was recorded in October and maximum value was reported in December, while at near water supply pump (S$_2$) the value of harness was in ranged between 215.30 ± 3.05 to 269.00 ± 8.54. The lower value of harness was observed in October and higher value was reported in December, whereas at Pimpalwadi site (S$_3$) it was ranged between 214.66 ± 5.50 to 281.00 ± 11.26. The minimum value of hardness was recorded in October and maximum value was reported in January. During the
second year of study period (2005-06) the value of hardness was ranged between 218.66 ± 8.32 to 266.00 ± 5.29. The minimum hardness was recorded in October while maximum hardness was reported in December at south site \((S_1)\), while at near water supply pump \((S_1)\) it was ranged between 230.33 ± 16.80 to 287.00 ± 1.73. The minimum level of hardness was observed in October and maximum level was reported in January, whereas at Pimpalwadi site \((S_3)\) it was ranged from 244.00 ± 22.71 to 287.00 ± 08.18. The lower level of hardness was recorded in October and higher level was reported in November.

In summer, during first year of study period (2004-05) the water hardness was ranged between 285.33 ± 5.50 to 357.66 ± 7.78 to at south site \((S_1)\). The minimum water hardness was recorded in February and maximum level of hardness was reported in May, while at near water supply pump \((S_2)\) it was recorded in ranged between 301.00 ± 3.60 to 333.30 ± 27.42. The minimum value were observed in April but in March it was reported to be at maximum value, whereas at Pimpalwadi site \((S_3)\) it was ranged between 293.00 ± 4.58 to 325.30 ± 11.71. The lower level of hardness was recorded in March and maximum level was reported in April. During the second year of study period (2005-06) the level of hardness was ranged between 300.00 ± 14.42 to 319.33 ± 16.04. The minimum level of hardness was recorded in February and maximum level of hardness was recorded in May at south site \((S_1)\) while at near water supply pump \((S_2)\) the hardness was ranged between 312.00 ± 2.00 to 336.33 ± 10.96. The lower level of hardness was observed in February and higher level of hardness was reported in March, whereas at Pimpalwadi site \((S_3)\) it was ranged from 298.33 ± 2.51 to 328.00 ± 7.21. The lowest water hardness was recorded in March while highest in April.

During the first year of study period (2004-05) the water hardness was recorded lower in winter at south site \((S_1)\) and higher in summer at near water supply pump \((S_2)\) while in second year of
study period (2005-06) the minimum level of hardness was recorded in monsoon and higher level of hardness was reported in summer at near water supply pump (S2).

**Chloride (mg/l):**

In monsoon, during first year of study period (2004-05) the chloride content was ranged between 232.66 ± 2.30 to 281.00 ± 3.60 at south site (S1). The lowest level of chloride was recorded in September but in July it was reported to be at highest level, while at near water supply pump (S2) the chloride was in ranged between 235.00 ± 50.56 to 274.66 ± 4.16. The lower value of chloride was observed in September but in July it was reported to be at higher level, whereas at Pimpalwadi site (S3) it was ranged between 231.33 ± 2.30 to 277.00 ± 7.54. The minimum value of chloride was recorded in September but in August it was reported to be at maximum level. During the second year of study period (2005-06) the chloride content was ranged between 225.66 ± 38.42 to 301.00 ± 22.86. The minimum level of chloride was recorded in July while maximum level of chloride was reported in August at south site (S1), while at near water supply pump it was ranged between 207.33 ± 3.50 to 312.00 ± 0.12. The minimum level of chloride was observed in July and maximum level was reported in August, whereas at Pimpalwadi site (S3) it was ranged from 226.00 ± 28.00 to 296.33 ± 19.13. The lower level of chloride was recorded in June and higher level was reported in August.

In winter, during the first year of study period (2004-05) the level of chloride was ranged between 255.00 ± 6.00 to 285.33 ± 2.30. The minimum level of chloride was recorded in September but in October it was reported to be at maximum level at south site (S1), while at near water supply pump (S2) it was ranged between 261.33 ± 3.21 to 284.66 ± 1.15. The minimum level of chloride was observed in January and maximum level was reported in October, whereas at Pimpalwadi site (S3) it was ranged from 258.00 ± 2.00 to 283.33 ± 5.03. The lower level of chloride was recorded in January but in
October it was reported to be higher level. During second year of study period (2005-06) the chloride content in water was ranged between 255.33 ± 14.18 to 322.00 ± 32.92 at south site (S₁). The minimum value of chloride was recorded in November but in October it was reported to be at maximum value, while at near water supply pump (S₂) the chloride was in ranged between 269.66 ± 21.45 to 341.33 ± 1.15. The lower value of chloride was observed in December but in October it was also reported to be at higher level, whereas at Pimpalwadi site (S₃) it was ranged between 332.00 ± 32.92 to 262.00 ± 5.29. The minimum level of chloride was recorded in October and maximum level of chloride was reported in November.

In summer, during first year of study period (2004-05) the level of chloride was ranged between 233.66 ± 3.51 to 280.00 ± 5.29 at south site (S₁). The minimum level of chloride was recorded in April but in March it was reported to be maximum level, while at near water supply pump (S₂) it was ranged between 233.33 ± 3.05 to 272.00 ± 5.29. The minimum values were observed in April but in March it was reported to be at maximum level, whereas at Pimpalwadi site (S₃) it was ranged between 232.66 ± 7.65 to 274.66 ± 4.16. The lower level of chloride was recorded in April but in March it was reported to be at higher level. During the second year of study period (2005-06) the chloride content in water was ranged between 236.00 ± 19.07 to 298.66 ± 26.63. The minimum level of chloride was recorded in April and maximum level of chloride was recorded in February at south site (S₁), while at near water supply pump (S₂) the chloride content was ranged between 172.33 ± 58.44 to 312.00 ± 8.00. The lower level of chloride was observed in March but it in February it was reported to be at higher level, whereas at Pimpalwadi site (S₃) it was ranged from 218.66 ± 13.31 to 296.00 ± 25.53. The lowest level of chloride was recorded in April but in February it was reported to be at highest level.

In the present study (2004-05) the chloride content was recorded lower in summer at near water supply pump (S₂) and higher
in winter at south site (S₁) while in second year of study period (2005-06) the minimum level of chloride was recorded in summer at near water supply pump (S₂) and higher level of chloride was reported in winter at South site (S₁) and.

**Phosphate (mg/l):**

In monsoon, during first year of study period (2004-05) the phosphate content was ranged between 6.23 ± 0.25 to 8.20 ± 0.30 at south site (S₁). The lowest value of Phosphate was recorded in September but in August it was reported to be at highest level, while at near water supply pump (S₂) the Phosphate was in ranged between 7.53 ± 1.34 to 8.80 ± 2.25. The lower value of Phosphate was observed in September but in June it was reported to be at higher level, whereas at Pimpalwadi site (S₃) it was ranged between 7.10 ± 0.10 to 9.63 ± 0.51. The minimum value of Phosphate was recorded in August and maximum value was reported in June. During the second year of study period (2005-06) the Phosphate content was ranged between 7.86 ± 0.90 to 8.53 ± 0.85. The minimum level of Phosphate was recorded in July while maximum level of Phosphate was reported in August at south site (S₁), while at near water supply pump it was ranged between 7.26 ± 0.20 to 8.66 ± 0.73. The minimum level of Phosphate was observed in August but maximum level was reported in June, whereas at Pimpalwadi site (S₃) it was ranged from 7.73 ± 0.64 to 8.66 ± 1.15. The lower level of Phosphate was recorded in August and higher level was reported in September.

In winter, during the first year of study period (2004-05) the Phosphate was ranged between 6.13 ± 0.15 to 7.33 ± 0.15. The minimum level of Phosphate was recorded in December and maximum level in January at south site (S₁), while at near water supply pump (S₂) it was ranged between 7.03 ± 0.56 to 6.76 ± 0.49. The minimum level of Phosphate was observed in October and maximum level of phosphate was observed in November, whereas at Pimpalwadi site (S₃) it was ranged from 6.50 ± 0.60 to 8.63 ± 0.75.
The lower level of Phosphate was recorded in October and higher level in January. During second year of study period (2005-06) the Phosphate content in water was ranged between 6.80 ± 1.04 to 7.66 ± 0.72 at south site (S₁). The minimum value of Phosphate was recorded in December and maximum value in January, while at near water supply pump (S₂) the Phosphate was in ranged between 7.23 ± 0.25 to 8.53 ± 0.32. The lower value of phosphate was observed in November and higher level in January, whereas at Pimpalwadi site (S₃) it was ranged between 6.10 ± 2.00 to 7.60 ± 1.76. The minimum level of phosphate was recorded in December and maximum level in January.

In summer, during first year of study period (2004-05) the level of Phosphate was ranged between 6.40 ± 0.3 to 8.33 ± 0.3 at south site (S₁). The minimum level of Phosphate was recorded in February and maximum level of phosphate was reported in May, while at near water supply pump (S₂) it was ranged between 7.26 ± 1.12 to 9.33 ± 1.25. The minimum levels were observed in April and maximum level of phosphate was reported in May, whereas at Pimpalwadi site (S₃) it was ranged between 9.00 ± 0.10 to 9.96 ± 0.98. The lower level of phosphate was recorded in February but in March it was reported to be at higher level. During the second year of study period (2005-06) the Phosphate content in water was ranged between 7.66 ± 1.07 to 10.00 ± 0.5. The minimum level of Phosphate was recorded in March and maximum level of Phosphate was recorded in April at south site (S₁), while at near water supply pump (S₂) the Phosphate content was ranged between 8.16 ± 0.3 to 9.56 ± 0.4. The lower level of Phosphate was observed in March and higher level of phosphate was noted in May, whereas at Pimpalwadi site (S₃) it was ranged from 8.80 ± 1.5 to 9.50 ± 1.32. The lowest level of Phosphate was recorded in March but in April it was reported to be at highest level.

During the present study, the phosphate content was lower in winter at south site (S₁) while higher level of phosphate was reported in summer at Pimpalwadi site (S₃) from both the years (2004-06).
Nitrate (mg/l):

In monsoon, during first year of study period (2004-05) the nitrate content was ranged between 4.70 ± 0.34 to 5.56 ± 0.30 at south site (S₁). The lowest value of nitrate was recorded in September but in August it was reported to be at highest level, while at near water supply pump (S₂) the nitrate was in ranged between 4.46 ± 0.47 to 6.36 ± 1.05. The lower level of nitrate was observed in September but in August it was reported to be at higher level, whereas at Pimpalwadi site (S₃) it was ranged between 4.43 ± 1.37 to 6.30 ± 0.20. The minimum value of nitrate was recorded in June but in July it was reported to be at maximum level. During the second year of study period (2005-06) the nitrate content was ranged between 3.93 ± 0.55 to 6.10 ± 0.20. The minimum level of nitrate was recorded in June while maximum level of nitrate was reported in July at south site (S₁), while at near water supply pump it was ranged between 3.80 ± 0.60 to 6.36 ± 0.15. The minimum level of nitrate was observed in June but maximum level was reported August, whereas at Pimpalwadi site (S₃) it was ranged from 4.43 ± 0.15 to 5.93 ± 0.37. The lower level of nitrate was recorded in June but in July it was reported to be at higher level.

In winter, during the first year of study period (2004-05) the nitrate was ranged between 5.16 ± 0.20 to 5.26 ± 0.05. The minimum level of nitrate was recorded in November and maximum level of nitrate was reported in January at south site (S₁), while at near water supply pump (S₂) it was ranged between 4.30 ± 1.20 to 5.33 ± 0.05. The minimum level of nitrate was observed in November but in October it was reported to be at maximum level, whereas at Pimpalwadi site (S₃) it was ranged from 4.00 ± 0.85 to 5.10 ± 0.64. The lower level of nitrate was recorded in November and higher level of nitrate was reported in December. During second year of study period (2005-06) the nitrate content in water was ranged between 3.66 ± 0.25 to 4.26 ± 0.20 at south site (S₁). The minimum value of nitrate was recorded in November and maximum in December, while
at near water supply pump (S2) the nitrate was in ranged between 4.20 ± 0.20 to 6.50 ± 0.20. The lower level of nitrate was observed in January but in October it was reported to be at higher level, whereas at Pimpalwadi site (S3) it was ranged between 3.50 ± 0.45 to 5.06 ± 1.48. The minimum level of nitrate was recorded in November but in October it was reported to be at maximum level.

In summer, during first year of study period (2004-05) the nitrate content was ranged between 4.80 ± 0.10 to 7.60 ± 0.17 at south site (S1). The minimum level of nitrate was recorded in February and maximum level in May, while at near water supply pump (S2) it was ranged between 4.40 ± 0.87 to 7.20 ± 0.85. The minimum levels were observed in February and maximum level in May, whereas at Pimpalwadi site (S3) it was ranged between 4.10 ± 1.15 to 7.26 ± 1.93. The lower level of nitrate was recorded in February and higher level of nitrate was reported in May. During the second year of study period (2005-06) the nitrate content in was ranged between 3.60 ± 0.36 to 6.26 ± 0.20. The minimum level of nitrate was recorded in February and maximum level of nitrate was recorded in May at south site (S1), while at near water supply pump (S2) the nitrate content was ranged between 4.30 ± 0.35 to 7.16 ± 0.15. The lower level of nitrate was observed in February and higher level in May, whereas at Pimpalwadi site (S3) it was ranged from 3.96 ± 0.37 to 7.00 ± 1.30. The lowest level of nitrate was recorded in February and higher level of nitrate was reported in May.

During the present study period (2004-05), the nitrate content was recorded lower in winter at Pimpalwadi site (S3) and higher level of nitrate was reported in monsoon at near water supply pump (S2). While in second year study period (2005-06) the nitrate content was recorded minimum in winter at south site (S1) and higher in summer at Pimpalwadi site (S3).

**Sulphate (mg/l):**

In monsoon, during first year of study period (2004-05) the sulphate content was ranged between 114.60 ± 03.05 to 154.60 ±
4.16 at south site (S₁). The lowest level of sulphate was recorded in June and highest level of sulphate was reported in September, while at near water supply pump (S₂) the sulphate was in ranged between 129.66 ± 16.07 to 157.33 ± 8.82. The lower level of sulphate was observed in June and higher level of sulphate was noted in September, whereas at Pimpalwadi site (S₃) it was ranged between 135.00 ± 3.60 to 164.00 ± 12.60. The minimum value of sulphate was recorded in June and maximum level of sulphate was reported in September. During the second year of study period (2005-06) the sulphate content was ranged between 117.66 ± 5.50 to 150.00 ± 3.46. The minimum level of sulphate was recorded in June while maximum level of sulphate was reported in September at south site (S₁), while at near water supply pump it was ranged between 137.30 ± 23.96 to 159.33 ± 5.57. The minimum level of sulphate was observed in July and maximum level was reported September, whereas at Pimpalwadi site (S₃) it was ranged from 138.00 ± 5.56 to 163.66 ± 12.42. The lower level of sulphate was recorded in June and higher level in was observed in September.

In winter, during the first year of study period (2004-05) the sulphate was ranged between 123.00 ± 2.64 to 163.33 ± 3.05. The minimum level of sulphate was recorded in December but it in October it was reported to be at maximum level in south site (S₁), while at near water supply pump (S₂) it was ranged between 130.66 ± 15.14 to 156.66 ± 7.57. The lowest level of sulphate was observed in December but in November it was reported to be at highest level, whereas at Pimpalwadi site (S₃) it was ranged from 140.33 ± 12.34 to 183.00 ± 9.53. The lower level of sulphate was recorded in October and higher level of sulphate was reported in January. During second year of study period (2005-06) the sulphate content in water was ranged between 122.66 ± 4.61 to 164.66 ± 4.61 at south site (S₁). The minimum value of sulphate was recorded in December and maximum value was reported in November, while at near water supply pump (S₂) the sulphate level was ranged between 130.66 ±
15.14 to 155.33 ± 18.57. The lower value of sulphate was observed in
December but in October it was reported to be at higher level,
whereas at Pimpalwadi site (S₃) it was ranged between 146.00 ±
18.24 to 172.66 ± 6.02. The minimum level of sulphate was recorded
in October and maximum level was reported in January.

In summer, during first year of study period (2004-05) the
sulphate content was ranged between 128.66 ± 11.71 to 142.66 ±
4.61 at south site (S₁). The minimum level of sulphate was recorded
in April and maximum level in May, while at near water supply pump
(S₂) it was ranged between 146.00 ± 29.46 to 154.33 ± 61.20. The
lower level of sulphate was recorded in March and higher level was
noted in April, whereas at Pimpalwadi site (S₃) it was ranged between
166.33 ± 18.50 to 236.33 ± 6.80. The lower level of sulphate was
recorded in February and higher level of sulphate was reported in
April. During the second year of study period (2005-06) the sulphate
content in water was ranged between 127.33 ± 11.30 to 147.33 ±
1.15. The minimum level of sulphate was recorded in April and
maximum level of sulphate was recorded in May at south site (S₁),
while at near water supply pump (S₂) the sulphate content was
ranged between 147.00 ± 7.54 to 181.66 ± 56.32. The lower level of
sulphate was observed in May but in April it was reported to be at
high level, whereas at Pimpalwadi site (S₃) it was ranged from 173.00
± 7.00 to 251.33 ± 16.56. The lowest level of sulphate was recorded
in February and higher level of sulphate was reported in April.

During the present study, the Sulphate content was lower in
monsoon at south site (S₁) and higher in summer at Pimpalwadi site
(S₃) from both the years (2004-06).

**Dissolved Oxygen (mg/l):**

In monsoon, during first year of study period (2004-05) the
dissolved oxygen level was ranged between 6.53 ± 0.32 to 7.93 ± 0.20
at south site (S₁). The minimum level of dissolved oxygen was
recorded in June and higher level of dissolved oxygen was reported in
July, while at near water supply pump (S₂) the dissolved oxygen was
in ranged between 6.13 ± 0.75 to 7.16 ± 1.70. The lower value of dissolved oxygen was observed in June and higher level of dissolved oxygen was noted in July, whereas at Pimpalwadi site (S_3) it was ranged between 5.96 ± 1.10 to 6.53 ± 1.40. The minimum value of dissolved oxygen was recorded in September but in July it was reported to be at higher level. During the second year of study period (2005-06) the dissolved oxygen level was ranged between 6.26 ± 0.15 to 8.26 ± 0.15. The minimum level of dissolved oxygen was recorded in June and maximum level of dissolved oxygen was reported in July at south site (S_1), while at near water supply pump it was ranged between 4.23 ± 1.87 to 6.13 ± 2.66. The minimum level of dissolved oxygen was observed in June and maximum level was reported July, whereas at Pimpalwadi site (S_3) it was ranged from 4.87 ± 1.56 to 6.90 ± 1.57. The lower level of dissolved oxygen was recorded in June and higher level in July.

In winter, during the first year of study period (2004-05) the dissolved oxygen was ranged between 7.10 ± 0.10 to 7.76 ± 0.15. The minimum level of dissolved oxygen was recorded in October and maximum level of dissolved oxygen was reported in January at south site (S_1), while at near water supply pump (S_2) it was ranged between 6.76 ± 1.20 to 6.83 ± 1.17. The minimum level of dissolved oxygen was observed in January but in January it was reported to at maximum level, whereas at Pimpalwadi site (S_3) it was ranged from 6.10 ± 0.98 to 6.33 ± 1.30. The lower level of dissolved oxygen was recorded in October and higher level in December. During second year of study period (2005-06) the dissolved oxygen content in water was ranged between 6.90 ± 0.90 to 7.31 ± 0.20 at south site (S_1). The minimum value of dissolved oxygen was recorded in January but in November it was reported to be at maximum level, while at near water supply pump (S_2) the dissolved oxygen was in ranged between 4.92 ± 2.06 to 5.30 ± 1.55. The lower value of dissolved oxygen was observed in December but in January it was reported to be at higher level, whereas at Pimpalwadi site (S_3) it was ranged between
5.43±1.50 to 5.83 ± 1.45. The minimum level of dissolved oxygen was recorded in January but in October it was reported to be at maximum level.

In summer, during first year of study period (2004-05) the dissolved oxygen level was ranged between 6.10 ± 0.10 to 7.53 ± 0.281 at south site (S₁). The minimum level of dissolved oxygen was recorded in April but in February it was reported to be at maximum level, while at near water supply pump (S₂) it was ranged between 4.90 ± 0.45 to 6.63 ± 1.43. The lower levels were observed in May but in February it was reported to be at higher level, whereas at Pimpalwadi site (S₃) it was ranged between 5.20 ± 0.55 to 5.90 ± 0.17. The lower level of dissolved oxygen was recorded in March and higher level of dissolved oxygen was reported in February. During the second year of study period (2005-06) the dissolved oxygen level was ranged between 6.23 ± 0.15 to 7.10 ± 0.10. The minimum level of dissolved oxygen was recorded in March and maximum level of dissolved oxygen was recorded in May at south site (S₁), while at near water supply pump (S₂) the dissolved oxygen level was ranged between 4.23 ± 0.95 to 5.83 ± 0.28. The lower level of dissolved oxygen was observed in April and higher level was reported in May, whereas at Pimpalwadi site (S₃) it was ranged from 4.00 ± 1.11 to 5.73 ± 0.49. The lowest level of dissolved oxygen was recorded in February and higher level of dissolved oxygen was reported in May.

During the present study, the dissolved oxygen content was recorded lower in monsoon at near water supply pump at (S₂) while higher in winter at south site (S₁) from both the years of study period (2004-06).

**Biological Oxygen Demand (mg/l):**

In monsoon, during first year of study period (2004-05) the BOD level was ranged between 11.56 ± 1.11 to 11.76 ± 1.53 at south site (S₁). The lower level of BOD was recorded in June and higher level of BOD was reported in August, while at near water supply pump (S₂) the BOD level was in ranged between 09.86 ± 0.63 to
12.56 ± 0.20. The lowest level of BOD was observed in September but in August it was reported to be at highest level, whereas at Pimpalwadi site (S₃) it was ranged between 14.13 ± 0.11 to 15.33 ± 0.60. The minimum value of BOD was recorded in June and maximum level was reported in July. During the second year of study period (2005-06) the BOD level was ranged between 11.50 ± 1.32 to 12.06 ± 0.66. The minimum level of BOD was recorded in August but in July it was reported to be at maximum level at south site (S₁), while at near water supply pump (S₂) it was ranged between 11.20 ± 1.21 to 12.76 ± 2.61. The minimum level of BOD was observed in August but in June it was recorded to be maximum level, whereas at Pimpalwadi site (S₃) it was ranged from 14.40 ± 0.17 to 15.60 ± 1.15. The lower level of BOD was recorded in June and higher level in August.

In winter, during the first year of study period (2004-05) the BOD was ranged between 10.06 ± 0.89 to 12.80 ± 0.75. The minimum level of BOD was recorded in January but in November it was recorded to be at maximum level at south site (S₁), while at near water supply pump (S₂) it was ranged between 11.00 ± 1.26 to 13.60 ± 1.30. The minimum level of BOD was observed in October and maximum in January, whereas at Pimpalwadi site (S₃) it was ranged from 12.76 ± 0.37 to 15.90 ± 0.52. The lower level of BOD was recorded in December and higher level in January. During second year of study period (2005-06) the BOD content in water was ranged between 9.93 ± 0.49 to 12.76 ± 0.55 at south site (S₁). The minimum value of BOD was recorded in January and maximum value was reported in November, while at near water supply pump (S₂) the BOD was in ranged between 13.70 ± 0.81 to 14.43 ± 0.40. The lower value of BOD was observed in November and lower level of BOD was recorded in December, whereas at Pimpalwadi site (S₃) it was ranged between 12.53 ± 2.00 to 14.00 ± 1.91. The minimum level of BOD was recorded in December but in November it was reported to be maximum level.
In summer, during study period of (2004-05) the BOD level was ranged between 11.46 ± 3.10 to 12.40 ± 3.10 at south site (S\textsubscript{1}). The minimum level of BOD was recorded in April and maximum level was reported in May, while at near water supply pump (S\textsubscript{2}) it was ranged between 12.50 ± 3.04 to 15.13 ± 2.80. The lower levels were observed in February and higher level was reported in May, whereas at Pimpalwadi site (S\textsubscript{3}) BOD level was ranged between 11.46 ± 1.05 to 13.16 ± 0.66. The lower level of BOD was recorded in February and higher level of BOD was reported in May. During the second year of study period (2005-06) BOD level was ranged between 10.30 ± 1.25 to 13.26 ± 2.05. The minimum level of BOD was recorded in February and maximum level of BOD was recorded in May at south site (S\textsubscript{1}), while at near water supply pump (S\textsubscript{2}) the BOD content was ranged between 14.23 ± 1.36 to 14.96 ± 2.23. The lower level of BOD was observed in March and higher level was reported in May, whereas at Pimpalwadi site (S\textsubscript{3}) it was ranged from 11.03 ± 0.55 to 12.80 ± 1.60. The lower level of BOD was recorded in March and higher level of BOD was reported in April.

During the present study period (2004-05), the BOD level was recorded lower in winter at near water supply pump and higher in summer at near water supply pump (S\textsubscript{2}). While in second year of study period (2005-06) the higher level of BOD was recorded in monsoon at Pimpalwadi site (S\textsubscript{3}) and lower level was reported in winter at south site (S\textsubscript{1}).

**Chemical Oxygen Demand (mg/lit):**

Degree of organic pollution can be asserted by COD. It is a measure of oxygen required in oxidizing organic compounds by involving a chemical oxidant. Seasonal variations in COD values of different site at Jaikwadi Dam are presented in table 34, 35 & 36 and graphically represented in Fig. 12.

In monsoon, during the study period (2004-05) COD level was ranged between 31.00 ± 2.00 to 42.00 ± 2.00 at south site (S\textsubscript{1}). The lower level of COD was recorded in June and higher level of COD was
reported in September, while at near water supply pump (S2) the COD level was in ranged between 28.33 ± 1.89 to 38.30 ± 2.02. The lowest level of COD was observed in July and highest level was reported in September, whereas at Pimpalwadi site (S3) it was ranged between 30.60 ± 3.54 to 40.16 ± 0.28. The minimum value of COD was recorded in July and maximum level was reported in September. During the study period (2005-06) COD level was ranged between 31.86 ± 2.12 to 41.30 ± 4.01. The minimum level of COD was recorded in June and maximum level was reported in September at south site (S1), while at near water supply pump (S2) it was ranged between 28.16±01.60 to 38.33±02.02. The minimum level of COD was observed in July and maximum level was reported in September, whereas at Pimpalwadi site (S3) it was ranged from 34.00 ± 09.17 to43.50 ± 05.63. The lower level of COD was recorded in July and higher level of C.O.D was found in September.

In winter, during the study period (2004-05) COD was ranged between 47.50 ± 1.32 to 63.83 ± 1.75. The minimum level of COD was recorded in October and maximum level was reported in January at south site (S1), while at near water supply pump (S2) it was ranged between 38.43 ± 0.92 to 64.63 ± 4.26. The minimum level of COD was observed in November and maximum level was found in January, whereas at Pimpalwadi site (S3) it was ranged from 44.00 ± 4.00 to 66.96 ± 4.42. The lower level of COD was recorded in November and higher level was reported in January. During second year of study period (2005-06) COD content in water was ranged between 44.76 ± 2.87 to 70.50 ± 5.76 at south site (S1). The minimum value of COD was recorded in October and maximum value was reported in January, while at near water supply pump (S2) the COD was in ranged between 38.26 ± 00.60 to 62.96 ± 04.71. The lower value of COD was observed in November and higher level of COD was recorded in January, whereas at Pimpalwadi site (S3) it was ranged between 47.30 ± 07.02 to 70.30 ± 09.39. The minimum level of COD
was recorded in October and maximum level was recorded in January.

In summer, during first year of study period (2004-05) the COD level was ranged between 64.00 ± 3.46 to 76.16 ± 2.25 at south site (S₁). The minimum level of COD was recorded in April but in February it was reported to be at maximum level, while at near water supply pump (S₂) it was ranged between 66.90 ± 9.37 to 71.13 ± 1.09. The lower levels were observed in February and higher level was reported in April, whereas at Pimpalwadi site (S₃) COD level was ranged between 67.00 ± 4.40 to 70.90 ± 4.13. The lower level of COD was recorded in April but in February it was reported to be at higher level. During the second year of study period (2005-06) COD level was ranged between 60.50 ± 3.00 to 73.80 ± 4.10. The minimum level of COD was recorded in April but in February it was reported to be at maximum level at south site (S₁), while at near water supply pump (S₂) the COD content was ranged between 68.56 ± 11.80 to 78.80 ± 11.00. The lower level of COD was observed in March and higher level was reported in April, whereas at Pimpalwadi site (S₃) it was ranged from 71.46 ± 14.30 to 73.60 ± 13.50. The lower level of COD was recorded in March and higher level of COD was reported in April.

In the present study period of (2005-06), the COD level was recorded lower in monsoon and higher in summer at near water supply pump (S₂) from both the years.
Soil:

pH:

In monsoon, during the present of study period (2004-05) the pH level in soil was ranged between 6.23 ± 0.25 to 7.50 ± 0.3. The lower level of pH was recorded in June and higher level was reported in September. During second year (2005-06) it was ranged between 6.43 ± 0.97 to 7.00 ± 0.26. The minimum level of pH was recorded in January but in November it was reported to be at maximum level.

In winter, pH level in soil was ranged between 6.50 ± 0.2 to 8.30 ± 0.2. The lower level of pH was recorded in October and higher level was reported in December in the year (2004-05). During second year (2005-06) it was ranged between 6.56 ± 0.51 to 7.90 ± 0.52. The minimum level of pH was recorded in October and the maximum level was reported in December.

In summer (2004-05), pH was ranged between 6.83 ± 0.76 to 8.20 ± 0.75. The lower level of pH was reported in February and higher level was observed in May. During second year (2005-06) it was ranged between 6.56 ± 0.73 to 7.73 ± 0.63. The minimum level of pH was reported in February and maximum level of pH was recorded in May.

In the present study in both the year (2004-06) pH level was recorded lower in monsoon and higher in summer compared to two other season (Table1; Fig. 1).

Alkalinity (mg/l):

In monsoon, during the present of study period (2004-05) the alkalinity level in soil was ranged between 140.00 ± 5.00 to 182.00 ± 2.00. The lower level of alkalinity was recorded in June and higher level was reported in August. During second year (2005-06) it was ranged between 148.33 ± 3.5 to 173.33 ± 4.16. The minimum level of alkalinity was recorded in June and maximum level was reported in September.

In winter, alkalinity level in soil was ranged between 176.30 ± 5.13 to 282.00 ± 3.46. The lower level of alkalinity was recorded in
January but in November it was reported to be at higher level. During second year (2005-06) it was ranged between 183.33 ± 4.16 to 241.00 ± 3.60. The minimum level of alkalinity was recorded in January but in October it was reported to be at maximum level.

In summer (2004-05), alkalinity level was ranged between 134.66 ± 4.16 to 166.66 ± 5.77. The lower level of alkalinity was reported in May but in February it was reported to be at higher level. During second year (2005-06) it was ranged between 136.33 ± 3.21 to 145.00 ± 13.22. The minimum level of alkalinity was reported in March and maximum level was recorded in April.

In the present study in both the year (2004-06) alkalinity level was recorded lower in summer and higher in winter compared to two other season (Table2; Fig.2).

**Sodium (mg/l):**

In monsoon, during the present of study period (2004-05) the sodium content in soil was ranged between 94.33 ± 4.04 to 104.00 ± 5.29. The lower level of sodium was recorded in June and higher level was reported in July. During second year (2005-06) it was ranged between 94.66 ± 6.42 to 113.33 ± 6.11. The minimum level of sodium was recorded in June and maximum level was reported in August.

In winter, sodium content in soil was ranged between 6.50 ± 0.2 to 8.30 ± 0.2. The lower level of sodium was recorded in October and higher level was reported in January. During second year (2005-06) it was ranged between 82.66 ± 5.03 to 107.00 ± 6.24. The minimum level of sodium was recorded in October and maximum level was reported in January.

In summer (2004-05), sodium content was ranged between 117.66 ± 10.21 to 135.33 ± 4.61. The lower level of sodium was reported in March and higher level in April. During second year (2005-06) it was ranged between 118.00 ± 9.16 to 132.66 ± 4.61. The minimum level of sodium content was reported in March and maximum level was recorded in April.
In the present study period of 2004-05) sodium level was recorded lower in winter and higher in summer compared to two other season (Table 3; Fig.3).

**Potassium (mg/l):**

In monsoon (2004-05), potassium content was ranged between 43.33 ± 4.162 to 81.33 ± 1.153. The lower level of potassium was reported in September but in July it was reported to be at higher level. During second year (2005-06) it was ranged between 41.00 ± 1.00 to 74.66 ± 3.053. The minimum level of potassium content was reported in September but in June it was reported to be at maximum level.

In winter, during the present of study period (2004-05) the potassium content in soil was ranged between 48.33 ± 7.63 to 78.00 ± 8.71. The lower level of potassium was recorded in October and higher level was reported in January. During second year (2005-06) it was ranged between 55.00 ± 5.00 to 84.33 ± 4.04. The minimum level of potassium was recorded in November and maximum level was reported in January.

In summer, potassium content in soil was ranged between 94.66 ± 3.05 to 64.00 ± 4.00. The lower level of potassium was recorded in May but in February it was reported to be at higher level. During second year (2005-06) it was ranged between 57.66 ± 2.51 to 93.33 ± 4.16. The minimum level of potassium was recorded in February and maximum level was reported in May.

In the present study in both the year (2004-06) potassium content in was recorded lower in monsoon and higher in winter compared to two other season (Table4; Fig.4).

**Sulphate (mg/l):**

In monsoon, during the present of study period (2004-05) the sulphate content in soil was ranged between 270.33 ± 13.79 to 306.33 ± 24.09. The lower level of sulphate was recorded in June and higher level was reported in September. During second year (2005-06) it was ranged between 272.66 ± 13.27 to 301.66 ± 29.29.
The minimum level of sulphate was recorded in June and maximum level was reported in September.

In winter, sulphate content in soil was ranged between 148.33 ± 2.88 to 221.33 ± 12.05. The lower level of sulphate was recorded in October and higher level of sulphate was recorded in December. During second year (2005-06) it was ranged between 152.33 ± 9.29 to 219.33 ± 10.06. The minimum level of sulphate was recorded in October and maximum level was reported in December.

In summer (2004-05), sulphate content was ranged between 117.66 ± 10.21 to 135.33 ± 4.61. The lower level of sulphate was reported in March and higher level in April. During second year (2005-06) it was ranged between 108.33 ± 12.58 to 152.33 ± 11.23. The minimum level of sulphate content was reported in April but in February it was reported to be at maximum level.

In the present study in both the year (2004-06) sulphate content in was recorded lower in winter and higher in monsoon compared to two other season (Table 5; Fig. 5).

Phosphate (mg/l):

In monsoon, during the present of study period (2004-05) the phosphate content in soil was ranged between 1.63 ± 0.41 to 5.63 ± 0.23. The lower level of phosphate was recorded in June and higher level was reported in September. During second year (2005-06) it was ranged between 1.60 ± 0.52 to 5.50 ± 0.17. The minimum level of phosphate was recorded in June and maximum level was reported in September.

In winter, phosphate content in soil was ranged between 1.83 ± 0.45 to 5.60 ± 0.2. The lower level of phosphate was recorded in October and higher level of phosphate was recorded in January. During second year (2005-06) it was ranged between 1.83 ± 0.55 to 5.53 ± 0.25. The minimum level of phosphate was recorded in October and maximum level was reported in January.

In summer (2004-05), phosphate content was ranged between 2.46 ± 0.25 to 5.60 ± 0.26. The lower level of phosphate was reported
In May but in February it was reported to be higher level. During second year (2005-06) it was ranged between 2.36 ± 0.46 to 5.56 ± 0.25. The minimum level of phosphate content was reported in May but in February it was reported to be at maximum level.

In the present study of both the year (2004-06) phosphate content in was recorded lower in monsoon and higher in winter compared to two other season (Table 6; Fig. 6).

**Nitrate (mg/l):**

In monsoon, during the present of study period (2004-05) the nitrate content in soil was ranged between 2.26 ± 1.51 to 3.33 ± 0.73. The lower level of nitrate was recorded in September but in July it was reported to be at higher level. During second year (2005-06) it was ranged between 1.53 ± 0.15 to 3.23 ± 0.15. The minimum level of nitrate was recorded in September but in June it was reported to be at maximum level.

In winter, nitrate content in soil was ranged between 1.46 ± 0.20 to 3.90±0.43. The lower level of nitrate was recorded in October and higher level of nitrate was reported in January. During second year (2005-06) it was ranged between 1.30 ± 0.10 to 2.73 ± 0.20. The minimum level of nitrate was recorded in October and maximum level was reported in January.

In summer (2004-05), nitrate content was ranged between 2.46 ± 0.25 to 5.60 ± 0.26. The lower level of nitrate was reported in May but in February it was reported to be higher level. During second year (2005-06) it was ranged between 2.36 ± 0.46 to 5.56±0.25. The minimum level of nitrate content was reported in May but in February it was reported to be at maximum level.

In the present study period of (2004-05) nitrate content in soil was recorded lower in summer and higher in monsoon compared to two other season while in second year (2005-06) the nitrate content was lower in winter and higher in monsoon compared to two other season (Table 7; Fig. 7).
Primary Productivity:

Gross Primary Productivity (GPP) (mg/c/m³/day):

In monsoon, during the study period gross primary productivity (GPP) level was in water of Jaikwadi dam ranged between 1075.33 ± 45.33 to 1202.00 ± 48.81. The lower gross primary productivity (GPP) level was recorded in July and higher level was reported in August. In winter, the gross primary productivity (GPP) level was ranged between 995.00 ± 008.71 to 1043.33 ± 038.68. The minimum level of GPP was recorded in November and maximum level in December. In summer, the gross primary productivity (GPP) was ranged between 1054.00 ± 057.15 to 1295.33 ± 163.05. The lowest value of was recorded in May but in April the gross primary productivity (GPP) was recorded in highest level.

During the study period the gross primary productivity (GPP) level in water was recorded higher in summer and lower level in winter compared to two other seasons (Table 1 and Fig; 1).

Net Primary Productivity (NPP) (mg/c/m³/day):

In monsoon, during the study period net primary productivity (NPP) level was ranged between 226.66 ± 28.53 to 269.33 ± 77.43. The minimum level of net primary productivity (NPP) was recorded in June while maximum level was reported in September. In winter, it was ranged between 174.33 ± 44.50 to 194.33 ± 5.85. The lower level of net primary productivity (NPP) was recorded in January and higher in December. In summer, during the study period net primary productivity (NPP) level was recorded in ranged between 404.00 ± 6.00 to 447.33 ± 30.98. The minimum level of net primary productivity (NPP) was recorded in February and maximum level of net primary productivity (NPP) was reported in May.

During the study period net primary productivity (NPP) level in water was recorded highest in summer and lowest level was reported in winter compared to two other seasons (Table 2 and Fig; 2).
DISCUSSION:

An ecosystem is a complex of abiotic and biotic features operating in a very harmonious manner and thus maintaining population and healthy communities of interacting organisms. Any extraneous influence shifts this balance on the variations appears through either changes in biotic and abiotic conditions and the seasonal fluctuations of various physio-chemical factors mediated due to various factors like morphometry etc. have important role in the distribution, periodicity, quality and quantitative composition of biota in aquatic ecosystem. The knowledge of all these factors is essential for identifying the suitability and fertility of an aquatic ecosystem (Sharma, 2002).

In an aquatic ecosystem, physico-chemical environment has profound influence on its biotic components. It controls diversity, biomass and spatial distribution of biotic communities in time and space. The physical and chemical parameters expert their influence both individually or collectively and their interaction produces abiotic environment which ultimately conditions the origin, development and finally succession of biotic communities. Further, biotic communities in turn, continuously alter abiotic environment thus a constant interaction between the abiotic and biotic components goes on in a dynamic ecosystem. Each ecosystem has its characteristic abiotic or biotic features and their thorough understanding is essential for its effective management and conservation. The considerable amount of literature has been generated on the physico-chemical dynamics of various lentic water bodies in India (Puri, 1989; Kumari, 1990; Shrama and subbamma, 1994; Sharma, 2001; Sharma, 2002, Gupta 2002, Kour, 2002, Akhtar, 2003, Nelofar, 2003; Jain, 2005).

Pure water is not colorless. It has got a pale green-blue tint in large volumes. Color in natural water may occur due to the presence of humic acids, fulvic acids, metallic ions such as iron and manganese, suspended matter, phytoplankton, weeds and industrial
wastes, etc. Color due to organic acids may not be harmful as such, but highly colored waters are objected on aesthetic grounds (Trivedy and Goel, 1985). Color in water can be caused by a number of contaminants such as iron, which changes in the presence of oxygen to yellow red sediment, humus and peat materials, plankton, weeds and industrial wastes. Colored industrial water may require color removal before discharged into water courses (APHA, AWWA and WEF, 1992). Color of the water is due to the scattered light rays form suspended particulate matter. It is generally bluish in reservoirs. In the present study of all sampling stations color of the dam water was observed brownish green in winter, which may be due to the addition of domestic sewage and also due to slit carried out by run off. Later on the water color changes to brown green and greenish in successive months in summer season may be due to the increased chlorophyll content of phytoplankton.

Odor is present mainly due to dissolved impurities often organic in nature. It is supposed to be ‘chemical senses’ as they depend on the actual contact with contact with receptor organ.

The odor may be of natural origin, caused by living and decaying aquatic organisms and accumulation of gases like ammonia and hydrogen sulphide etc. Many algae also impart test and odors to water. Odors of any artificial origin are due to the discharge of industrial wastes which includes many chemicals imparting different odor and tastes (Voznay, 1981).

Odor is recognized as a quality factor affecting acceptability of drinking water (and foods prepared it), tainting of fish other aquatic organisms, and esthetics of recreational waters. Most organic and some inorganic chemicals contribute taste or odor. These chemicals may originate from municipal and industrial waste discharges, from natural sources such as decomposition of vegetable matter, or from associated microbial activity and form disinfectants or their product. In the present study, odor of Jaikwadi dam water at all sampling stations was fishy in winter, musky foul in summer and fishy foul in
The parameter of temperature is basically important for its effects on the chemistry and biological reactions in the organism in water. A rise in temperature of the water leads to the speeding up of the chemical reaction in water, reduces the solubility of gases and amplified the tastes and odors. Water in the temperature range of 7°C to 11°C has a pleasant taste and is refreshing. At higher temperature with less dissolved gases, the water become tasteless and even does not quench the thirst. At elevated temperatures metabolic activity of the organism increases, requiring more oxygen but at the same time the solubility of oxygen decreases thus accentuating the stress. Organism in water has varying sensitivities to temperature (Auti, 2002).

Water temperature play an important role in biological activates. It govern solubility of the oxygen, carbon dioxide, bicarbonates- carbonate equilibrium etc. Thermometers are used in common practice to measure the change in temperature to measure the water temperature, is dipped directly into the water body and a constant reading is noted. Water temperature is very important parameter, because it influences the biota in a water body by affecting activities such as behavior, respiration and metabolism. It is necessary to study temperature variations in water body and in animals ecophysiological and toxicological aspects because, water density and oxygen content are temperature related and hence temperature indirectly affects osmoregulation and respiration of the animal (De, 2002).

Among the water quality parameters, water temperature is one of the most important factors having profound influence on the biotic communities. In general, air and water temperature depends on geographical location and metrological conditions such as rainfall, humidity, cloud cover, wind velocity, etc. Particularly planktonic
communities which constituting very base of the energy cycles and are get affected due to temperature influence (Atiya Khan and Zafar, 1983). Apart from limiting distribution depending on tolerance limits, temperature also control the metabolic rate in all organisms and increase in productivity (Vernberg and Liaknoich, 1965). Kaven and Bell (1965) have reported an increase in gross productivity with an increase in temperature.

In the present study, the water temperature level was ranged between $24.89 \pm 0.68 \degree C$ to $32.19 \pm 2.06 \degree C$. The lower level of temperature was recorded in winter at Pimpalwadi site ($S_3$) and higher level was reported in summer at near water supply pump ($S_2$) [Table 1, 2 & 3; Fig. 1]. Environmental temperature fluctuate both daily and seasonally and is responsible for heating and cooling of river water. The atmospheric temperature depends upon radiation from the sun as well as evaporation, relative humidity, wind, length of the day and cloud cover. The measurement of water temperature is of vital importance for calculation of the solubility of oxygen and CO$_2$ and carbonates-bicarbonates equilibrium. In the Godavari River, at Pravarasangam the temperature range of 18$\degree$C to 32$\degree$C was reported by Pondhe and Jadhav (2000). The fluctuations in water temperature had a relationship with the air temperature, which also showed same seasonal trend. Reservoir having water temperature more than 22$\degree$C are found to have a high productivity (Mathew, 1975). Studies on physicochemical and biological characteristic of lakes, rivers and dams water has been done by many researchers from time to time (Busulu et.al., 1967; Chakaraborty et.al., 1977; Adwant, 1981; Joshi and Bisht; 1993; Gill et.al., 1993; Pulle, et.al., 2001; Mohmmad Musaddiq and Anil Forkmare 2002; Dutta, et.al., 2002; Mishram 2003; Patil et.al., 2005 and Kadam et.al., 2007).

William (1987) stated that temperature is the determining factor in the seasonal distribution of organisms. The relationship can be reduced between chemical conditions and plankton population at any specific time. Salaskar and Yeragi (1997) stated that the
temperature between 29.7°C to 31.8°C, minimum in winter and maximum in summer. However, water temperature ranged between 28.7°C and 31.2°C which showed close relationship between atmospheric and water temperature. Similar observations were reported by number of workers (Munnawar, 1970; Swarnalatha, 1994 and Chandrasekhar, 1996). The water temperature accelerates the rate of chemical reaction, reduces the solubility of gases, amplifies taste and elevate overall metabolic rate (Auti, 2000). Generally, rise in temperature accelerates the rate of chemical reaction, reduce the solubility of gases, amplifies taste and elevate overall metabolic rate.

To submerse, water temperature followed a common pattern it was higher in summer and relatively lower in winter and monsoon. Similar observation is also made by Welch (1948), Rice (1938), Zafar (1964), Lakshminarayan (1965), Munawar (1970), Swarnalatha and Narsingrao (1991), Singh (1979), Vyas et. al., (1979), Auti (2002), Zadpade (2002) and Patil & Yardi (2006). The water temperature was lower than the air temperature. A similar pattern of fluctuation in day and night temperature was observed by Michael, (1964) and Bohra, (1975). The ambient temperature remained greater than the water temperature except in winter and similar results were also reported by Borse and Bhave (2000). A significant correlation between ambient temperature and water temperature in present study was also supported by Kato (1941), Ganpati, (1962) and Verma, (1967), Zadpade (2000), Patiwar (2002), Patil et.al., (2003), Auti (2002), Patil and Yardi (2006), Hiware and Pawar (2007). The low water temperature noticed during the monsoon due to monsoon rain, cloudy sky and cold weather (Muley and Patil, 2006). At higher temperature, solubility of oxygen and other gases decreases and water becomes tasteless while metabolic activity of organism increases. Saxena et. al., (1966) recorded maximum temperature of water 35.5 °C in river Ganga at Kanpur.
Welch, (1952) stated that the shallow water reacts more quickly to changes in atmospheric temperature. Bandela et.al., (1998) reported that the effect of atmospheric temperature was amply reflected in water changes. Malathi (1990) studied that the air temperature brings out spatial and temporal thermal changes in natural water that manifest in setting up of convectional current and thermal stratification. Narasimharao and Jaya (2001) observed that rise in temperature can be resulted in high rate of evaporation which may caused decline in water level during summer months. Kaushik et.al., (1990) observed that the temperature affects the seasonal cycle and abundance of entomofauna in the aquatic ecosystem. Joshi (2000) stated that temperature plays an important role which influences on the periodicity and abundance of phytoplankton. The ambient temperature in surface water is of vital importance as it determines the degree of dissociation of dissolved salts in water system and controls to some extent the rate of oxidation of organic matter. Temperature affects chemical toxicity or complex because temperature alone may be lethal toxicant, which may alter thermal limits in unpredictable ways and influence on the survival of animals (Akarte, 1985; Muely, 1985).

pH is a measurement of the intensity of acidity or alkalinity and measures the concentration of hydrogen ion in water. Most natural waters are generally alkaline due to presence of sufficient quantities of carbonates. pH of water gets drastically changed with time due to the exposure to air, biological activity and temperature changes. Significant changes in pH occur due to disposal of industrial wastes, acid in drainage etc. in natural waters, pH also changes diurnally and seasonally due to variation in photosynthetic activity which increases the pH due to consumption of CO2 in the process (Goel, 1884).

pH has no direct adverse effects on health, however, a lower value below 4 will produce sour taste and higher value above 8.5 an alkaline taste. Higher values of pH have trend the scale formation in
water heating apparatus and also reduce the germicidal potential of chloride. High pH induces the formation of trihalomethanes which are toxic. pH below 6.5 starts corrosion in pipes, thereby releasing toxic metals such as Zn, Pb, Cd and Cu, etc. in the water supplies, pH is an important factor in fixing alum does in drinking water treatment (Shinde, 2006).

The pH of natural water usually lies in the range of 4.0 to 8.5. Its value is governed largely by carbon dioxide, bicarbonates and carbonate equilibrium. It may be affected by humic substances change in the carbonate equilibrium due to the bioactivity of plants and in some cases by hydroligeable salts. The pH of water has a marked affect upon the toxicity of substances commonly present in water body, especially on chemicals that ionizes under the influence of pH (Pondhe, 2002).

In the present study, the pH level in water was ranged between 7.50 ± 0.15 to 8.22 ± 0.23. The lower level of pH was recorded in winter at south site (S1) and higher level was reported in summer at near water supply pump (S2) [Table 4, 5 & 6; Fig. 2]. Which can be attributed to inflow of acidic and alkaline water from Godavari river at paithan and which may have dominance in the absorption of heavy metals on to clay minerals. The hydrogen ion normally associated with high photosynthetic activity in water (patil, 1993.)

Generally slightly alkaline conditions are favorable for growth of algal species in lotic systems (Welch, 1952; Blum, 1956). It affects species diversity and distribution in an ecosystem. The factors like photosynthesis, exposure to air, disposal of industrial waste and domestic sewage affect pH (Saxena, 1987). The pH levels were within the limits, set for protection of aquatic life (6.5 to 9.0) (USEPA, 1975); irrigation (5.5 to 9.0) and domestic use (7.0 to 9.0) (ICMR, 1975). Palanivel and Rajaguru, (1999) stated that the high amount of TSS and pH was mainly due to the discharge of industrial and domestic wastes into the river. Singh (1988) reported that the pH was alkaline in tanks ranged between (7.2 to 8.2). Chandrasekhar, (1997)
recorded alkaline pH in Sarrornagar lake water due to high quantum of sewage. Similar observations were noted by Malathi (1999), Pathak (1999) and Mohd Ilyas (2001). In urban centers, pH of water is also highly influenced by nature of pollution in the form of sewage and industrial effluents (Kodarkar, 1995). Generally, pH of dams ranges between slightly acidic to alkaline in the bicarbonate range between 6.0 to 9.0 (Moore, 1950; Ganapati, 1960; Singh, 1965; Verma et al., 1978).

Specific conductivity is a numerical expression of its ability to carry an electric current. Further, it is an indicator of ionic composition and any alteration in its values reflects change in ionic concentration in a proportional way (Rodhe, 1994). The Conductivity of water in the reservoir is a characteristic which is mainly associated with the dissolved material or solute concentration present in the reservoir water (Kulkarni et al., 1995). Conductivity and dissolved solids are directly proportional to each other mainly due to ionic composition of water. The factors such as rainfall and biodiversity cause changes in ionic composition and nature of bottom deposits influence the conductivity (Anitha, 2002). Conductivity is important parameter for detecting fish community and plays an important role in the release of nutrients and consequently the productivity of aquatic ecosystem. It is also dependent upon large amount of salts and silts carried by adjacent canals to agriculture sites. The chemical nature of solids dissolved in water mainly depends on the nature of bed rocks and soil developed for it. Other physicochemical factors which govern chemistry of water may also influence soil salinity especially in arid conditions (Holmes and Talsma, 1981).

In the present study, the EC level in water was ranged between $207.16 \pm 17.46 \mu\text{mhos/cm}$ to $530.41 \pm 27.54 \mu\text{mhos/cm}$. The lower level of EC was recorded in summer at south site ($S_1$) and higher level was reported in monsoon at near water supply pump ($S_2$) [Table 7, 8 & 9; Fig. 3]. The high value in monsoon could be due to high
quantum of domestic sewage inflow. And low values in summer may be due to lower temperature and stabilization of water due to sedimentation. The electrical conductivity is a result of electrolyte present in water is generally low in inland non saline dams. Total dissolved solid showed a positive relationship with electrical conductance (Auti, 2002; Zadpade, 2002; Pulle et al., 2003; Joshi and Sakhre 2003). The seasonal variations in the conductivity in the present study may be due to the increased concentration of salts because of discharge of domestic sewage and organic matter from the different rivers joined to Godavari, which brings ionic substances into the dam. High levels of conductivity reflect pollution status as well as tropic levels of the aquatic body.

Total Alkalinity is a measure of capacity of water to neutralize a strong acid. Alkalinity is generally imparted by the salts of carbonates bicarbonates, phosphates, nitrates, borates, silicates etc. together with hydroxyl ion concentration in Free State. However, most of water rich in carbonates and bicarbonates with lower concentration of other alkalinity imparting ion (Trivedi and Goel, 1984). Water having 40 mg/l or more level of total alkalinity is considered to be more productive than waters of lower alkalinity (Moyle 1946). It is measured as buffering capacity of water. The range of total alkalinity in India was between 40 mg/l to over 1000 m/l (Jhingran, 1977).

Alkalinity is the acid neutralizing capacity of water which depends on the strength of carbonates in a sample and it determines the availability of free carbon-dioxide which is essential for photosynthesis and thus is directly related to productivity. In general, alkaline water increases productivity and supports the diversity of aquatic life (Malathi, 1999). The total alkalinity of the water is high may be due to the carbonates and bicarbonates (Nayak et al., 1982). Oomachan and Belsare (1986), Ghosh and George (1989) and Das, (1978) stated that high alkalinity indicates pollution. The alkalinity is harmful for irrigation, which leads to the soil
damage, crop yield and imparts bitter taste to the water. The pH free of carbon dioxide alkalinity in water body is interrelated. George (1966) observed that in an ecosystem with pH range of 7.0 to 9.0, alkalinity concentration remain high. It is true in present study that reflecting high alkalinity in winter and sharp decline in monsoon (Pahwa and Mehrotra, 1966; Ray et al., 1966). The increase in total alkalinity during winter is due to concentration of nutrients in water, and decreases during monsoon due to dilution with rain water (Goel et al., 1980). The maximum alkalinity of dam water may be due to the accumulation of carbonate salts from the surrounding and removal of carbon dioxide due to excessive photosynthesis. Wetzel (1972) reported that during the photosynthesis, carbon dioxide and calcium carbonate is precipitated by algae and macrophytes. Alkalinity and hardness are closely related to each other. With high alkalinity, hardness and chlorides are found to be more productive and support rich flora and fauna in summer. Moyle (1946) reported similar phenomena. The water was alkaline with pH between 8.5 to 9.5 which do not support the growth of aquatic ecosystem (Robert et al., 1940; Das, 1978). However, when total alkalinity was high and varied from 220 to 360 mg/l, such high alkalinity indicated pollution (Patil and Patwari, 2003). Choudhary et al., (2006) reported that the amount of bicarbonate was more during rainy season than the winter and summer, due to the inflow of mineral salts along with water by rivers. Kaushik et al., (1990) observed that the pond water was found to be mildly polluted, comparatively due to dilution of water, in winter it was moderately polluted and in summer, it was grossly polluted.

In the present study, the alkalinity level in water was ranged between 409.45 ± 86.26 mg/l to 551.16 ± 33.62 mg/l. The minimum level of alkalinity was recorded in monsoon at south site (S1) and maximum level was reported in summer at Pimpalwadi site (S3) [Table 10, 11 & 12; Fig. 4]. It was observed that the higher values of total alkalinity with high bicarbonate contents in the dam. This
further supported by the observations made by Brion Moss (1973) and Wetzel (1983), that the dam is highly productive from the viewpoint of alkalinity of its water. Sayam et al., (1987) pointed out the total alkalinity of Kukutpally stream water between 200 to 475 mg/lit. Rupvathi and Radhakrishnan (1983) in study of a quarry pool, observed decreased in alkalinity during rainy season. The total alkalinity ranged between 90 to 120 mg/l, the value was slightly higher in summer. This may be attributed to increase the rate of organic decomposition during which CO2 is liberated, which reacts with water to form HCO3, thereby increasing the total alkalinity in summer. Similar suggestions have been given by Seenayya (1997) and Harshey et al., (1983), Moyle (1994), Sreenivasan (1995), Maduri et al., (2004), have suggested that a water body with alkalinity values>40 mg/l is nutritionally rich.

Hardness is due to concentration of alkaline earth metals. Ca++ and Mg++ ions are the principal cations imparting hardness, it prevents leather forming. Ca++ and Mg++ are the most abundant elements in natural surface and ground water and exist mainly as carbonates, bicarbonates and carbon dioxide constituted major source of inorganic carbon to producers in an aquatic ecosystem. They also act as buffers regulating the pH of the medium. The bicarbonate alkalinity is considered more important which influences the density of bottom fauna (Needham and Usinger, 1956). The ecological significance of major cations i.e. calcium and magnesium in the biotic dynamics of aquatic fauna and flora is a well-established fact. Hardly a group of fresh water animal exists in which the distribution of some species has not been related to calcium concentration in the environment (Macan, 1961). Magnesium is essential for flora for chlorophyll biosynthesis and enzymatic transformations, particularly the phosphorylation in algae, fungi and bacteria (Wetzel, 1975). Hardness often employed as indicator of water quality depends on the concentration of carbonate and bicarbonates salts of calcium and magnesium or sulphate chloride or
other anions of mineral acids. Sawyer and McCarti (1966) have classified water in to four classes on basis of hardness; soft with hardness of 75 mg/lit, moderately hard with hardness ranging between 75 to 150 mg/lit, hard with 150 to 300 mg/lit. Hardness in different zones of Kukatpally nala increased down streams (Reddy, 1991). Senger et.al. (1985) observed that the total hardness of water varied from 221.0 to 828.0 mg/l in up stream and 230.0 to 919.0 mg/l in down stream. Nirmal Kumar (1989), observed a positive relation between total hardness and alkalinity and anions, same result has been observed by Sreenivasan, (1966).

In the present study, the hardness level in water was ranged between $136.66 \pm 45.95$ mg/l to $272.66 \pm 96.42 \pm 33.32$ mg/l. The lower level of hardness was recorded in monsoon at south site ($S_1$) and higher level was reported in summer at near water supply pump ($S_2$) [Table 13, 14 & 15; Fig. 5]. The principal natural sources of hardness in water are sedimentary rocks, seepage and run off form soils. Hard water normally originates in areas with thick top soil and limestone formations (Sawyer and McCarty, 1963). Hardness of water is due to presence of.divalent metallic cations like Ca, Mg, ferrous iron and manganese. The variation of this parameter is likely due to both temperature influences as well as trophic status of the lake during different seasons and additional effect of human activities. Zafar (1966) opined that pH of water is dependant upon the relative quantities of calcium, carbonates and bicarbonates. According to Reid, (1966) the pH value between 7 to 9, bicarbonates are of great significance. It is well known that the increasing hardness decreases the toxicity of cations of aquatic fauna as well. Available data indicates that toxicity is a linear function of hardness. In majority of natural water, the most abundant ions are bicarbonate (Child’s, 1971). Decrease of toxicity with increase in hardness may be caused by the reaction of these cations with bicarbonates. The relations between carbonates, bicarbonates and carbon dioxide have been reported in the polluted zones by number of workers (Nirmal kumari,
The total hardness can be attributed to carbonate rich sediments and leaching of the same (Bahura, 1998). Hardness of water is not a pollution parameters but indicating water quality mainly in terms of Ca$^{++}$ and Mg$^{++}$ expressed as CaCO$_3$ (Dey, 1999). The increase in hardness can be attributed to the decrease in water volume and increase in the rate of evaporation at high temperature (Kaur and Sharma, 2001). Rajurkar et al., (2003) has classified waters with hardness values ranging from 60-180ppm as moderately hard to hard.

Chlorides as chloride anions (Cl$^-$) are major anions in wastewater. The chloride concentration is higher in organic wastes and its higher level in natural water is definite indication of pollution from domestic sewage. A number of workers have reported that chloride in lake waters was due to domestic sewage (Kodarkar et al., 1991; Chandrasekhar and Kodarkar, 1994; Swarnalatha, 1994). The ecological significance of chloride lies in its potential to regulate salinity of water and exert consequent osmotic stress on biotic communities. The increase in chloride concentration in lakes, rivers and dams is due to the discharge of municipal and industrial wastes reported by Kant and Raina (1990).

In the present study, the chloride content was ranged between 243.66 ± 59.93 mg/l to 294.25 ± 33.32 mg/l. The lower level of chloride was recorded in summer at Pimpalwadi site (S$_3$) and higher level was reported in monsoon at near water supply pump (S$_2$) [Table 16, 17 & 18 Fig. 6]. Generally, sewage contributes to the salinity of water in the case of urban wetlands and chloride was higher in monsoon due to runoff water from city solid wastage. Yardi et al., (2005) also reported that the chloride was higher in winter and summer due to the evaporation water losses. Further, lower values were encountered in winter, which can be attributed to dilution effect from renewal of water mass from summer stagnation in monsoon. In winter again low range is recorded due to the high sedimentation rate in relatively stable environmental conditions. Chloride in water
is contributed by the salts of sodium, potassium and calcium. Larger contents of chloride in fresh water is an indicator of organic pollution (Ganapathi, 1960). High value of chloride and calcium in drinking water are generally not harmful to human being but high concentration of chloride may affects a person who already suffers from diseases of heart and kidney. Trivedy et al., (1990) recorded high concentration of chlorides are the indicators of large amount of organic matter in the water due to eutrophication. Verma and Dalela (1975) pointed out that presence of high amount of chloride influences the amount of dissolved oxygen, which may adversely affect the number of aquatic organisms. Chloride content, which was high during the present study, may be due to anthropogenic activities in addition with the progression of a trophy and edging of the dam. The maximum value during monsoon and minimum value was recorded during winter season. The fluctuations of chloride are governed by the dilution of inflow of water, concentration by evaporation of water and input form surface run-off during monsoon because of dilution. Koshy and Nayar (1999) reported high volume in the range 110 mg/l to 176 mg/l.

The rise in chloride in summer and winter may be due to the rise in temperature and evapor-transpiration, which could be explained by the fact that the presence of chloride salts may interfere with other nutrients, which are being utilized in the process of photosynthesis. In monsoon, the chlorides were recorded minimum due to the rainfall. The rising concentration depends upon dumping of effluents from of municipal as well as industrial activities, as well as prevailing human activities. Similar observations were recorded by number of workers (Mishra and Yadav, 1978; Patil, 1993; Chandrasekhar and Kodarkar, 1994; Kulkarni et al., 1995, Patil and Sawane, 2006; Pawar and Mane, 2006).

In natural water, phosphates, are present in small quantities. Generally aquatic ecosystems receive excess of this nutrient through untreated domestic sewage and agriculture runoff (Malathi, 1999).
Normally phosphate acts as a limiting nutrient in the process of eutrophication and lakes can be aesthetically classified in to good, fair and bad on the basis of % phosphates loading (Edmondson, 1991). Chandrasekher (1996) reported that phosphates from Saroornagar Lake in Hyderabad ranged between 0.5 to 3.1 mg/lit. Phosphates and nitrates are the main nutrients responsible for the process of eutrophication that leads to ultimate degradation of an aquatic ecosystem (Reynolds, 1991, Kodarkar et al., 1991, Kodarkar and Chandrasekhar, 1995, Malathi, 1999). Phosphate is an essential metabolic element, which normally occurs in low concentration in natural aquatic ecosystem and hence, often acts as a limiting factor for primary production (Rigler, 1956).

In the present study, the phosphate content was ranged between 6.47 ± 0.57 mg/l to 8.95 ± 0.60 mg/l. The lower level of phosphate was recorded in winter at south site (S_1) and higher level was reported in summer at Pimpalwadi site (S_3) [Table 19, 20 & 21; Fig. 7]. The most of Indian lake is subjected to pollution from domestic sewage increases the level of phosphates and exhibits all signs of eutrophication (Kodarkar, 1995). Low value of phosphate in summer indicates low productivity. Pondhe and Jadhav (2000) stated that tropical water always possess phosphate in sufficient quantities. Phosphate levels were high in summer and low in winter, which is responsible for the process of eutrophication. Demare et al., (2002) has suggested that phosphate levels of 0.30 m/l and beyond is indicative of eutrophication when algal blooms can be expected. Excess concentration of nitrate and phosphate brings eutrophication and is considered sufficient to stimulate algal bloom (Bahura, 2001). Phosphate is generally recognized as the key nutrient in the productivity of water. The main sources of phosphate baring rocks and leasing of soil in catchments (Sawyer, 1947).

Phosphate shows a direct relationship with phytoplankton crop as it constitutes as important plankton nutrient (Vyas, 1968). Goel et al., (1980) recorded phosphate maxima during summer season.
This concentration of phosphate however may increase in the lake by contamination or by receiving domestic sewage. Similar observations were made by Brinley, (1942b) and Jolly and Chapman, (1966). Young et al., (1973) have reported an increase in the phosphate concentration in the river water polluted by sewage. Due to the washing activities there is an entry of detergent into the water body. The detergent formulations normally contain a high level of phosphate and its influx to lentic water bodies removes the limiting effects of nutrients, which leads to a change in the biological characteristics of the receiving water body. Berg (1948) made similar observations, that the high values of phosphate was recorded in summer season which may be due to the demand by the phytoplankton and zooplankton and it is a critical nutrient in the eutrophication process along with nitrates (Vollen Welder, 1968; Kynes, 1979; Allen and Karmer, 1972; Pondhe and Jadhav, 2000; Bhosle, 2001; Auti 2002; Mohd. Abdur and Khan, 2002; Zadpade 2002; Pawar et al., 2003; Swane 2006; and Mane & Pawar, 2007).

The most highly oxidized form of nitrogen compounds commonly present in natural waters is nitrate. Nitrate are the end product of the biochemical oxidation of ammonia which is formed chiefly as a result of the breaking of proteins. Significant sources of nitrate are chemical fertilizers, decayed vegetable and animal matter, domestic effluents, sewage, sludge disposal to land, industrial discharge, lactates from diffused dumps and atmospheric washout. Domestic sewage contains very high amount of nitrogenous compounds. Runoff from agricultural fields is also contains nitrate. Atmospheric nitrogen fixed into nitrates by the nitrogen-fixing organism is also a significant contributor to nitrates in the water (Trivediy and Goel, 1986). Unpolluted natural water contains usually only minute amount of nitrate. High nitrate content in potable water is harmful for children and cause anemia (methamoglobinanaemia) (De, 2002).
Determination of nitrate levels is important as it helps in measuring the pollution status and gives relative picture of availability of decomposable organic matter (Malathi, 1999). The urban water bodies receive excess of nitrates through untreated domestic sewage (Kodarkar and Chandyakkar, 1995). The nitrogen pool of limnetic environment comprises two components namely the organic materials liberated by the biota or generated in the heterotrophic bacterial activity upon proteinaceous substrate. The second component is made up of inorganic compounds of nitrogen such as ammonia, nitrite and nitrate. A great deal of work on the distribution pattern of different forms of nitrogen and their interrelationship in fresh water has been made by Ganapati (1960), Zafer (1964 and 1966), Lakshiminarayana (1965); Geroge (1966), Venkateswarlu (1969), Rao (1977), Pondhe (2000), Auti (2002), Patil and Yardi (2005).

In the present study, nitrate content in dam water was recorded in the range 4.10 ± 0.30 mg/l to 6.36 ± 0.91 mg/l. The lower level of nitrate was recorded in winter at south site (S1) but in monsoon at near water supply pump (S2) it was reported to be at higher level [Table 22, 23 & 24; Fig. 8]. High nitrates coupled with phosphate are responsible for eutrophic condition of the water body with its characteristics manifestation (Kodarkar and Chandyakkar, 1995). The nitrates were high in summer season due to the relatively stable thermal stratification and incomplete circulation of water (Zafar, 1966). The biological destruction is accelerated in summer and greater biological demand due to tremendous increase in the density of algal population and the lack of incoming water. Another factor for its decline was the denitrification by facultative anaerobic bacteria that also thrive in aerobic conditions and utilize nitrate as an exogenous terminal hydrogen ion acceptor in the oxidation of organic substances (Alexander, 1961; Bandurski, 1965). Monsoon maxima of nitrate is linked with heavy run off of deposited organic matter as well as
substantial contribution came from the macrophytes and their epiphytic biota which occupied a large segment of the lake basin (Golterman, 1976; Das, 1978; Wagh et al., 2000; Auti, 2002; Sakhre and Joshi, 2002; Venkateshwarlu and Mallikarjun, 2002; Kumar, 1984; Janaki Ram Rao et al., 2006; Srinivasarao et al. 2007)

Golterman (1975) reported that nitrates may also show two distinct erosion pattern of variation, due to rainfall and leaching form agricultural lands. According to Whitman, (1992) in the river draining primarily agricultural lands drainage is a major sources of nitrogen and chlorides, whereas in industrialized and urbanized catchments, the major portion of these ions is derived from effluents.

Involvement of sulphate species in geochemical and biological process and use of sulphate fertilizers contribute to water pollution. Increase in sulphate concentration may be related to pollution of the water body by runoff water, which contains relatively large quantities of organic and mineral sulphur compounds. In urban areas, industrial emission of $\text{SO}_2$ gas and its contact with atmospheric moisture forming sulphurous acids constitutes one of the important sources of sulphate pollution in surface waters. Chemically, sulphate plays an important role in forming salts of Ca and Mg to give permanent hardness to water and biologically pollution of sulphate in the form of sodium salt upsets normal functioning of the intestine. Water containing magnesium sulphate at levels about 1000 mg/l acts as a purgative in human adults, lower concentrations may still affect new users and children (USEPA, 1975; Auti, 2002; Patwari, 2002; Zadpade, 2002; Pulle et al., 2003; Joshi and Sakhre 2003).

Sulphates are found in appreciable quantities in all the natural waters, particularly high in arid and semi arid regions where natural waters, in general have high salt content (Saxsena, 1987). Sulphate ions usually occur in natural waters, many sulphate compounds are readily soluble in water. Most of them originate from the oxidation of sulfite areas, the solution of gypsum and unhydrate the presence of shale’s, particularly those rich in organic compounds and existence
of industrial wastes in humid region. Sulphate itself has never been a limiting factor in aquatic ecosystems; the normal levels of sulphate are more than adequate to meet plant needs. Odorous conditions are easily created when water is overloaded with organic wastes to the point that oxygen is removed, shows as electron acceptor, is often used for the breakdown of organic matter and produces \( \text{H}_2\text{S} \) of a rotten eggs smell. Sulphate is a important constituent producing water with calcium and magnesium. High amounts of sulphate impart bitter taste to water (Bhalerao and Khan, 2000). Sulphur exists in a number of oxidation states, from the most oxidized sulphate to the most reduced sulphide. The biological reduction of sulphur can take place in both aerobic and anaerobic conditions. Under the aerobic conditions reduction of sulphate is an assimilatory process (Tuttle, 1980; Killharn et al., 1981), where as under the aerobic conditions a specialized group of anaerobic bacteria, the sulphate reducing bacteria use sulphates as the terminal electron acceptors and form hydrogen sulphide, as a result of the dissimilatory reduction of sulphate (Hunter, 1965). The sulphate reducing bacteria are also terminal oxidizers of organic matter in a sulphate rich environment (Lovley and Klug, 1983). The supply of sulphate ions in surface water under natural conditions are due to the reactions of water with sulphate containing rock and with the biochemical and partly chemical oxidation of sulphides and other compounds of sulphur. The most stable form of sulphur in water at 25 °C and atmospheric pressure are \( \text{SO}_4 \), \( \text{H}_2\text{SO}_4 \), free sulphur and \( \text{HS-H}_2\text{S} \) (Singh, 1984).

In the present study, sulphate content in dam water was recorded in ranged between 132.00 ± 17.485.05 mg/l to 199.25 ± 35.74 mg/l. The sulphate level was lowest in monsoon at south site (S1) and highest in summer at Pimpalwadi site (S3) [Table 25, 26 & 27; Fig. 8]. A high concentration of sulphate stimulates the action of sulphur reducing bacteria, which produce hydrogen sulphide a gas highly toxic to fish life. The concentration of sulphate was higher in
all the seasons in all stations at Jaikwadi dam may be due to lentic environment and inflow of sewage wastewater in to the dam through river in monsoon season. High concentrations of sulphate and sulphides were also observed in a number of eutrophic lakes and dams waters (Kemp et al., 1972). The high concentration of chlorides, sulphates, nitrates and phosphates associated with the depletion of oxygen led to anoxic or anaerobic conditions in the dam water reported by Kulkarni et al., (1995), Salaskar and Yeragi (1997), Shastri, et al., (1999), Narasimha Rao and Jaya Raju (2001).

Sulphate itself has never been a limiting factor in aquatic ecosystems, the normal levels of sulphate are more than adequate to meet plant needs. Odorous condition is easily erected when water is over loaded with organic waste to the point that is removed, then SO$_2$ as electron acceptor is often used for the breakdown of organic matter and produces H$_2$S and a rotten egg smell (Welch, 1981). Sulphate exhibited a direct relationship with dissolved oxygen, whenever the oxygen content was more, the sulphate also increased.

Dissolved oxygen is one of the most important abiotic factors influencing life in an aquatic ecosystem. Its depletion perhaps is the most critical manifestation of pollution and effects of low level of dissolved oxygen. The dissolved oxygen level in natural water depends on physical, chemical and biological activities of the water body. Concentration of dissolved oxygen decreases with increase in temperature. A healthy stream or lakes should have adequate dissolved oxygen. The oxygen rich water, bacteria and protozoan and microorganisms multiply rapidly and then become food for advanced aquatic animals. The presence of dissolved oxygen is essential to maintain variety of forms of biological life in water. Non-polluted surface waters naturally saturated with dissolved oxygen (Auti, 2002).

Analysis of dissolved oxygen plays an important role in controlling water pollution activities and water treatment processes. Oxygen is very important and vital for all the living organisms
because it is essential to maintain the metabolic processes responsible for the production of energy for reproduction and growth. The solubility of atmospheric oxygen depends on temperature. The factors, which are responsible for the status of dissolved oxygen in water, are temperature, light and turbidity (Pawar and Mane, 2006).

Light is very important which governs the photosynthetic activity, therefore the change in light intensity affects the population of phytoplankton thereby affecting the process of photosynthesis. Turbidity affects the light penetration due to the presence of total suspended solids and thereby affecting the process of photosynthesis, which is responsible for the release of the oxygen (Prasad, 1999).

The dissolved oxygen contents have greater significance as it furnishes useful information about biological and biochemical reaction taking place in the water. The determination of dissolved oxygen forms the basis of biochemical oxygen demand. Biochemical oxygen demand test is a procedure which involves the determination of oxygen consumed by living organism mainly bacteria while utilizing the organic matter present in the waste (Patwari, 2002).

The study of dissolved oxygen is important in aquatic system, which brings about various biochemical changes and hence many ecologists have discussed its effects on metabolic activities of organisms. Smet and Evans (1972), Hancock (1973), Mishra and Yadav (1978), Boyd (1982), Kulkarni, (2002) and have discussed seasonal fluctuations in dissolved oxygen and reported that DO was maximum in winter and minimum in summer months. It is noticed that reduction of nitrates into ammonia continue during the summer when the concentration of the dissolved oxygen is 0.4 m/l. however during monsoon DO content improved (2.8 to 4.2 mg/l) but the optimum value of 4.5 mg/l is never fulfilled and this is responsible for the accumulation of ammonia in the system. This ammonia is utilized by phytoplankton’s present into the water and part of it is converted into free nitrogen by nitrifying bacteria. The similar results
were obtained in other rivers of India. Zadpade, (2002); Patwari (2002), Patil and Yardi (2006), Pawar and Mane (2006).

The minimum and maximum values of the dissolved oxygen of surface water varied between 0.2 to 10.5 mg/l in Cooum River at Chennai and very low concentration of dissolved oxygen was found at the polluted stations in river Narmada at Hoshanagabad. Mahadevan and Krishna Swamy (1978) found level of dissolved oxygen generally high at 11 stations, the mean value being at or above 80%, saturation in river vaigai. Relatively lower values of dissolved oxygen and anaerobic situations in this zone resulted into very low biotic diversity and biomass (Reddy, 1991). Distribution of macro-invertebrates is influenced by a number of environmental factors and dissolved oxygen content is the major limiting factor (Ruttner, 1963). Anwar and Siddiqui (1988) pointed out that the monthly variation of dissolved oxygen of the river varied from 4.2 ppm to 8.6 ppm round the year. The distribution of macro-invertebrate fauna appears to be related to dissolved oxygen of the water. Lower DO in summer may be due to high temperature and low solubility of oxygen in water consequently affecting the BOD (Singh et. al., 1991). With the progress of winter, DO increased to its highest value which may be due to circulation by cooling and draw down of DO in water (Hunnan, 1979). Further the DO content of water was low in summer because of its enhanced utilization by microorganisms in the decomposition of organic matter (Sangu and Sharma, 1987).

In the present study, DO level was recorded in ranged between 5.05 ± 0.17 mg/l to 7.44 ± 0.28 mg/l. The DO level was lower in winter at near water supply pump (S2) and higher in monsoon at south site (S1) [Table 29, 30 & 31; Fig. 9]. The minimum level of dissolved oxygen required for dam activities is 5.0 mg/lit. Result similar to the present study has been reported for river Godavari as 5.36 to 7.34 mg/l (Rajput, 1999).

Dissolved oxygen showed higher values during the post monsoon season and lower values during the summer season. The
latter could be due to the decrease in oxygen solubility because of increase in temperature and salinity of the water column during the summer seasonal observations have been made by Singh, (1999) from the waters of the Ganga River. DO in water at a given temperature depend on factors like temperature of water, the concentration of dissolved salt, biological activity and geology of basins of river. The solubility of atmospheric oxygen in fresh water ranges from 14.6 mg/l at 0°C to about 7.0 mg/l at 35 °C under one atmospheric pressure. Microbes play key role in the loss of oxygen as energy to break down long, chained organic molecules into simpler, more stable end products such as carbon-dioxide, water, phosphate and nitrate (Jain, 1996). As the organic molecules are broken-down by microns, oxygen is removed from the system and must be replaced by exchange at the air-water interface.

The importance of dissolved oxygen in aquatic ecosystem is bringing out various biochemical changes and its effect on metabolic activates of organism have been discussed by many ecologist (Verma, 1967; Goel, 1987; Patil, 1993; Pondhe 1998; Shashri, 1999; Hiware and Jadhav 2002; Auti, 2002; Nisar Shaikh, 2004; Ugale and Hiware 2005; Patil and Yardi 2006 and Salve and Hiware, 2007).

It is well known fact that the oxygen balance of a dam is tagged with the photosynthetic and respiratory activities of its biota and the chemical oxidation on one hand and the prevailing physico-chemical condition on the other. The observed low values of the dissolved oxygen in the lake water might be attributed to the activity of domestic sewage causing anoxic conditions due to the decay of organic matter. The maximum values of dissolved oxygen are probably accounted due to progressive lowering of turbidity resulting in resumption of photosynthetic activity in the dam in winter. In winter, the dissolved oxygen is sufficiently present in water body because of decrease in temperature of land surface. Low summer values of dissolved oxygen are attributed to higher water temperature, BOD and low rate of photosynthesis from reduced algal
biomass (Patil, 1993). Sewage loading pattern and pollution from detergents and domestic waste has a very complex and unpredictable influences on dissolved oxygen. In general, the monsoon pattern and the total turnover of water profoundly influences dynamics of dissolved oxygen gases like oxygen and carbon dioxide. Ellis (1937) pointed out that the minimum dissolved oxygen content in water for maintaining fish life in healthy conditions is 5.0 mg/lit at 20°C. Masood Ahmed and Krishanamurty (1990) showed a positive correlation between temperature and sunlight and soluble gases like dissolved oxygen. Shashtri et al., (1999) observed a strong correlation between pH and dissolved oxygen.

BOD is an important parameter that indicates the magnitude of water pollution by oxidizable organic matter. The main sources of organic pollution include untreated domestic sewage, agricultural runoff, containing residual fertilizers and certain industrial effluents. The components of oxidizable matter include carbonaceous organic matter, nitrogenous compounds and chemically reducing compounds. In natural course the organic matters on oxidation enters into bio-geo-chemical cycles. However, when an aquatic ecosystem receives excessive organic pollution load due to low availability of dissolved oxygen, net biological oxygen demand generates. BOD thus can be defined as the quantity of dissolved oxygen in mg/lit required under test condition (aerobic bacteria) for the organic matter for test sample (Khabade et al., 2002). BOD is an important parameter that indicates the magnitude of water pollution by the oxidisable organic matter and the oxygen used to oxidize inorganic material such as sulphides and ferrous ions. Low value of BOD in comparatively wider months may be due to lesser quantity of total solids, dissolved solids, and suspended solids in water as well as to the quantitative number of microbial population (Anitha, 2002; Auti, 2002; Patil and Yardi, 2006). Winniewski, (1989) showed the highest BOD during the summer months which may be attributed to the maximum biological activity at elevated temperature. Musaddiq
et al., (1985) and Abbasi et al., (1996) noticed an inverse correlation between BOD and DO in the polluted ponds and streams. High BOD values during summer induce high growth of bacteria (Bandela et al., 2002). Voznaya (1981) also found the high population of microorganisms in Russian reservoirs during the month of May and July. Organic material may exert demand for oxygen in a water body and oxidisable nitrogenous compound, which may react with dissolved molecular oxygen tensions in water (Unni, 1983).

In the present study, BOD level was recorded in ranged between 11.42 ± 1.12 mg/l to 14.71 ± 0.33 mg/l. The lower level of BOD was recorded in monsoon while higher level of BOD was reported in winter at near water supply pump (S2) [Table 31, 32 & 33; Fig. 11]. BOD values more during winter than summer and monsoon as reported by Shukla and Pandey (2001), Auti and Patwari (2002). This indicates that untreated domestic sewage is being sources of dam, resulting in accumulation of large amounts of organic matter in the lake thereby giving a high biological oxygen demand. BOD gives an idea of the quantity of biodegradable organic substances to aerobic in water which is subjected to aerobic decomposition of microorganisms. It provides a direct measurement of state of pollution (Prashanthi and Jeevanrao, 1999). Present study indicates that BOD was quite high in summer though the impact of pollution was found to be localized, yet it creates the stress in environment for biotic communities. The lower BOD values which is been slashed down in monsoon indicating the retaining capacity of dam water to recover from pollution stress of organic substances. High values of BOD in summer were also reported by Kulkarni et al., (1995) in Satadpur reservoir. According to Sharma and Sarang, (2000) the high values of BOD in the summer season may be due to the high pollution load and reduced water flow, while lower values in monsoon and winter may be due to dilution of water. However, in the present study BOD value ranged from Jaikwadi dam in monsoon and winter indicated that the dam have got the self purification capacity.
to dilute the organic load because of sufficient oxygen content in this

dam.

COD is a measure of oxygen required to oxidize the organic
matter by a strong chemical oxidant. It is used to measure the
pollution strength of domestic and industrial wastes. COD gives an
idea of concentration of substances, which may undergo immediate
chemical oxidation. All organic compounds with little exception can
be oxidized by the action of strong chemical oxidants under acidic
condition.

In the present study, COD level was recorded in ranged
between 32.50 ± 4.36 mg/l to 74.30 ± 03.93 mg/l. The COD level
was lower in monsoon and higher in summer at near water supply
pump (S2) [Table 34, 35 & 36; Fig. 12]. It is the measure of oxygen
required in oxidizing the organic compounds present in water by
means of chemical reactions involving oxidizing substances such as
potassium chromate and potassium permanganate. The estimation
of COD is of great importance for water having unfavorable
conditions for the growth of microbes, such as in the presence of
toxic chemicals. The chemical oxygen demand test determines the
oxygen required for chemical oxidation of organic matter with the
help of strong chemical oxidant. The COD is a test, which is
measured in terms of quantity of oxygen-required oxidation of
organic matter to produce carbon dioxide and water. It is a fact that
all organic compounds with few exception, can be oxidized for the
action of strong oxidizing agents under acidic condition, COD test is
useful in pinpointing toxic condition and presence of biologically
resistant substances. High organic pollution indicates high value of
COD. In Burnal dam, COD values ranged between 4.8 to 26.3 mg/lit.
(Hiware and Jadhav, 2002) and between 10.0 to 46.5 mg/lit
exceeding the limit. Chaudhary and Pandey (2004) reported that 18.0
to 40 mg/l in Suryu river water.
Soil:

Soil constitutes the upper part of the earth crust with weathered materials and organic matter as main constituents, on which plants are growing and in which organisms live. It is an extremely dynamic and complex system exhibiting continuous interplay between soil biota and between the living and non-living components of soil. The biological activity of microorganisms in soil is known to be regulated by several abiotic factors. It is, therefore, interesting to understand the distribution of microbial population in ranging environments as they reportedly play an important role in the mineralization or organic matter and degradation of several environmental pollutants and soil contaminants (Trivedy, 1988).

The soil owe their distinctive character to the fact that they contain excessive concentration of either soluble salts or exchangeable sodium, or both for agricultural purposes, such soils are regarded as a class of problem soils that require special remedial measures and management practice. The saline soil is the soil that contains sufficient soluble salts to impair its productivity. Similarly alkali soils can be defined in term of productivity as influenced by exchangeable sodium probably the most common problem involves soils that contain an excess of both soluble salts and exchangeable sodium of such soils are referred as saline alkali soils under humid condition soluble salts originally present in soil material for those. These has been uncertainly in the past regarding the effect of intangible K on physical properties of soil (Tripathi and Pandey).

Exchangeable Na and K should be considered as additive in defining alkali (soils) formed by weathering of minerals generally carried out downward into the ground water and are transported ultimately by stream to the ocean. In the arid regions leaching and transportation of soluble salts to ground water is not completed as in humid regions. Leaching is usually local in nature and soluble salts may not be able to transport, because less rainfall available to leach and transport of salts due to high evaporation rate which tends to
concentrate the salts in soil and in surface water. Restricted drainage is a factor that usually contributes to salinization of soil and may involves the presence of high ground water (table) or low permeability of soil, under such conditions upward movement of saline water are due to evaporation of surface water resulted in the formation of saline soil. The extent of saline areas then formed may vary from ten acres to hundred of square miles of was saline soils in India formed by this manner. Similar observations was made under the present study.

Soil pH is one of the most indicative measurements. The pH of soil help to get the idea for addition of lime or sulfur, required plant nutrient, type of fertilizers required as because some fertilizers will acidify the soil and others may raise the pH. As soil pH is typically measured as soil-solution pH, it is also an indicator of the proportions of basic and acidic exchangeable ions present in the soil. This is because these ions in the soil solution are in equilibrium with the exchangeable ions. The soil pH is dependent upon soil minerals and amount of rainfall (Bauder, 2001).

A soil pH determines what nutrients are available to plants. Soil tend to become acidic as a result of rainwater leaching away basic ions (calcium, magnesium, sodium and potassium), carbon dioxide from decomposing organic matter and root respiration dissolving in soil, formation of strong organic and inorganic acids. In alkaline soils, essential nutrients such as manganese and iron become insoluble and unavailable to plants (Auti, 2002).

Soil and their characteristic are of great important in an agriculture economy. The pH is one of the most important factors in soil quality management. It indicates that acidity, neutrality and alkalinity of soil (Waugh, 2001).

In the present study, the pH level in soil was ranged between 6.67 ± 0.57 to 7.47 ± 0.56 mg/l. It was lower in monsoon and higher in summer. Chandrashefar and Dubey (1996) reported that successive effluent in river affected the pH of irrigated soil and lead
to accumulation of salts in the soil. Increase in soil pH has significant effect on seed germination (Reddy et al., 1981; Sharma and Kaur, 1994; Oblisami, 2003).

The pH value of a normal soil can be considered as an index of its exchangeable cation saturation (USDA, 1954). Hence, the availability of many plant nutrients depends on the pH of the soil. The nutrients like iron (Fe), zinc (Zn), Copper (Cu), manganese (Mn) etc. are available more in acidic than in alkaline soils. In alkaline and calcareous soils, the availability of potassium (K), phosphorus (PO4), iron (Fe) and many minor elements is reduced and hence, the addition of fertilizers carrying these elements is necessary for such soils. Thus the pH of soil plays a very important role in maintaining the soil fertility.

When sample is said to be alkaline the concentration of the hydroxyl ions exceeds that of hydrogen ions. Alkalinity is the acid neutralizing capacity of water which depends on the strength of carbonates in a sample and it determines the availability of free carbon which is essential for photosynthesis and is directly related to productivity. In general alkalinity in dam water which increase the support to the diversity of aquatic life. The alkalinity is harmful for irrigation, which leads to the soil damage and crop yield and imparts bitter taste to the water (Malathi, 1999).

Oomachan and Belsare (1986), Ghosh and Geroge (1989) pointed out that high alkalinity indicates pollution of water and is harmful for domestic purpose, irrigation which leads to the soil damage and crop yield and imparts bitter taste to the water (ICMR, 1976; Patwari 2000).

In the present study, the alkalinity level in soil was ranged between 140.16 ± 3.74 mg/l to 227.50 ± 5.13 mg/l. It was lower in summer and higher in winter. High value of alkalinity was observed in winter due to the anaerobic sediments, bacteria reduce nitrate to ammonium and NP; phosphorus remains soluble because it does not form insoluble compounds with metals under these conditions (Libe,
1992; Ingall and Jahnke, 1997; Auti, 2002). Upadhay and Rana (1991) showed that alkalinity value was inversely related to the water level.

High concentration of sodium and potassium in water adversely affects the soil structure reported by (Goltrman et al., 1978; Singh and Harshey, 1983; Yen et al., 1996; Chandra Prakash, 2001; Pondhe, 2005). The adverse effect on the soil caused by high Na+ concentration is known as sodium hazard (USDA, 1954). The high concentration of sodium affects soil permeability, texture and leads in reduction of water intake. It acts deflocculating agent and displaces the divalent cations like calcium, magnesium and cumulatively the soil losses its productivity (Boulton and Loyd, 1978).

Many times use of poorer quality of waters has led to the deterioration of the soils. The surface water contain high concentration of salts, often representing disproportionate amount of bicarbonate (HCO₃⁻) and sodium (Na⁺) ions cause adverse effects on the soils. The studies on effect of irrigation waters on the soil properties have been carried out by several workers (Hausenbuiller et al., 1960; Singh et al., 1967; Yaron and Thomas, 1968; Singh and Sharm, 1970; Paliwal and Maliwal, 1971; Madhav Rao et al., 1979).

In the present study sodium content in soil was recorded in ranged between 90.16 ± 13.71 mg/l to 124.58 ± 7.56 mg/l and potassium it was reported in the range between 57.83 ± 14.45 mg/l to 78.66 ± 12.56 mg/l. In both the samples Na⁺ and K⁺ are lower in winter and higher in summer compared to two other seasons. Potassium is essential as plant nutrients. It originates from mineral weathering, inorganic fertilizers, soil amendments viz. gypsum, composts and manures and irrigation waters (Koch et al., 1980). Potassium of potash (K) regulates plant processes such as water balance, transpiration, photosynthesis, and resistance to disease,
cold and drought. Potassium deficiency symptoms vary widely (Auti, 2002).

Sulphur exist in number of oxidation state, from the most oxide sulphate to the most reduced sulphide. The biological reduction of sulphur can take place in both aerobic and anaerobic conditions. Under the aerobic condition reduction of sulphate is assimilatory process (Tuttle, 1980; Killharn, 1981), where as under anaerobic condition specialized group of bacteria use sulphate as a terminal electron acceptor and form hydrogen sulphide (Shrivastva and Tripathi, 1982). The sulphate reducing bacteria are also terminal oxidizers of organic matter in sulphate rich humid environment.

Suplhates are soluble in water and can directly be determined in the soil solution. Sulphate like chlorides corrode steel and affect the solidity and strength of concrete, sodium sulfate causes foaming, sulphate cause laxative effect. Sulphate in exists of 250 mg/l causes gastrointestinal irritation. In addition to domestic sewage industrial effluents also add sulphates to aquatic environment and hence high level of sulphate is an indicator of organic pollution (Malathi, 1999). In the present study the sulphate content in soil was ranged between 127.25 ± 21.95 mg/l to 287.91 ± 15.37 mg/l. It was lower in summer and higher in monsoon.

Phosphates, mostly in the form of PO$_4^{3-}$ are available in large quantities on agricultural lands as it is applied as a fertilizer, Polyphosphates used in water may combine with Ferric oxide to form a glassy phosphate flims. Phosphorus like nitrogen is a good nutrient and encourages the growth of bacteria and aquatic plants. As a nutrient excess of phosphate stimulates development of algal blooms.

In the present study the level of phosphates was recorded in ranged between 3.2 ± 1.72 mg/l to 4.07 ± 1.71 mg/l. It was lower in monsoon and higher in winter season. Phosphates and nitrates are the main nutrients responsible for the process of eutrophication that leads to ultimate environmental degradation (Reynolds, 1991; Kodarkar et al., 1991; Kodarkar and Chandrasekhar, 1995).
Phosphate in the nature present mostly in inorganic forms. The major sources of phosphate are domestic sewage, detergents, agricultural effluents with fertilizers and industrial wastewaters. The higher concentration of phosphate is indicator of pollution (Kodarkar, 1995; Chandrasheker, 1997; Malahiti, 1999 and Anitha, 2002). Phosphate and nitrate are the main nutrient responsible for the process of eutrophication that leads to ultimate environmental degradation (Reynolds, 1991 and Kodarkar et al., 1991) Jensen and Andersen (1990) discussed the possibility that blooms green which are often associated with NO_3^- levels in the lake decreased the sedimentation. Phosphorus (P) contributes to root growth, fruit growth and disease resistance (Auti 2002).

Nitrogen is a major constituent of the earth's atmosphere and occurs in many different gaseous forms such as elemental nitrogen, nitrate and ammonia. Natural reactions of atmospheric forms of nitrogen with rainwater resulted in the formation of nitrate and ammonium ions. While nitrate is a common nitrogenous compound due to natural processes of the nitrogen cycle, anthropogenic sources have greatly increased the nitrate concentration, particularly in surface water. The largest anthropogenic sources are septic tanks, application of nitrogen-rich fertilizers to turfgrass, and agricultural processes (Pondhe, 2005).

In the present study the nitrate content in soil was ranged between 2.05 ± 0.66 to 2.75 ± 0.44 mg/lit. The lower level of nitrate was reported in winter while higher level was recorded in summer. Nitrate is a problem as a contaminant in surface water and (primarily from groundwater and wells) due to its harmful biological effects. High concentrations can cause methemoglobinemia, and have been cited as a risk factor in developing gastric an intestinal cancer (Pondhe, 2005).

Nitrate is found in surface soil water only when they are badly polluted by sewage. Extensive usage of nitrogenous fertilizers such
as urea and Ammonium sulphate has sufficiently polluted ground as well as surface water with nitrate (Malathi, 1999).

Surface runoff in urban areas modifies and degrades stream water and sediments to detriment of abstract drinking water, recreational users and the aquatic and riparian ecology (Chandler, 1994; Ellis and Hvitved- Jacobsen, 1996). Improvement in the chemical quality of water in the UK and elsewhere has been achieved through large scale curtailment of point source discharges and upgrading of combined sewer outflows, but these mitigation measures have highlighted the impact of non-point source pollution particularly storm water runoff from urban structures, pavements, streets, roofs, guttering and buildings (LaZaro, 1990; Marsalek, 1990; Quek and Forster, 1993). This is of major concern for managers of freshwater ecology and consideration of the principal, critical, limiting factor in achieving ecological integrity in urban watercourses (Lenat and Crowford, 1994; Pitt et al., 1995; Characklis and Wiesner, 1997; Lee and Bang, 2000). Contamination of water and attachment of pollutants to streambed sediments impair aquatic flora and fauna. Macro-invertebrates at the base of the food chain are particularly vulnerable and therefore can act as indicator of a rivers biological health. An effort to characterize more accurately the cumulative impact of human activities on ecosystems, monitoring is slowly moving away from reliance on chemical indicators towards use of ecological measures (McCormick and Carins, 1994; Rochfort et al., 2000). Urban runoff entrains sediments that accumulate on surfaces between runoff contained 250 to 300 mg/l of suspended sediments (Haughton and Hunter, 1994). Upon reaching the receiving water body the majority of the sediment settled is the principal underlying reason for reduced bio-integrity with reasons well summarized by Pawar et al., (1977).

Various toxic contaminations that are found in rarely detectable amounts in the water column can accumulate in sediments at much higher level. Sediments can serve as both a sink
for contaminants and a source of contaminants to the water column and organisms. Short term input of suspended sediment from construction sites have been shown to reduce the abundance of fish and invertebrates during and after construction (Ogbeibu and Victor, 1989). In Ontario, Taylor and Roff (1986) showed road construction runoff led to noticeable reduction in the abundance of species downstream for six years. The impacts may be long-lived. The time scale of construction, soil, climate, the size of receiving water body, the hydrobiology pathways linking the construction area with receiving watercourse and the historic records of sedimentation and contamination in the catchment (Catallo and Gambrell, 1987).

**Levels of Primary Productivity:**

Primary productivity is the rate at which suns radiant energy is stored by photosynthetic activity of producer organisms (various form of algae and higher plants in water) in the form of organic substances, which can be used as food material. The primary productivity is thus the basis of whole metabolic cycle in natural aquatic ecosystems, the remainder is consumption and decay. The consumers’ inhabiting the system utilizes the organic matter synthesized by primary producers. To estimate, primary production can measure the carbon uptake as well as oxygen production. In primary production gross primary productivity (GPP) is the rate of photosynthetic activity and include the organic matter used in respiration during the period of measurement. Production of organic matter by plankton is of most important because it indicate that the whole aquatic food chain is great disorder. This is the main reason behind the fluctuation of aquatic fishers (Arvind kumar, 1996). The fishery potential is directly correlated to the primary production. It helps in regulating community metabolism the primary production is not constant but goes on changing from place to place and season to
season, this is mainly due to variability in temperature light, illumination, carbon, minerals etc. (Trivedy and Goel, 1985).

Primary productivity is rate at which macrophytes and microphytes manufacture, fix organic matter and entrapping solar energy by photosynthesis. The duration of photoperiod intensity of sunlight and temperature and the concentration of essential nutrients influence the organic productivity in water bodies (Horner-Devine, 2003). Nath (1998) stated that a small population under favorable condition might have high rate of production as a large population under favorable conditions may have low rate of production. According to Nair, (1975) and Joshi (1995) primary productivity is directly correlated with solar radiation. In a freshwater ecosystem periphyte and sediment dwelling algae contribute significantly to the primary productivity. The hydrological parameters play an important role in the formation of primary production. In monsoon season, the bottom living sediments are brought at the surface and mixed with each other to bring it to nutrient value. According to Ganpati and Pathak (2002) during monsoon months the nutrients are brought up to the surface layer. Increased vertically stability of the water particularly in the post monsoon period keeps the nutrient levels low in correlation of periphyton production with biomass standing crop, hydrographic parameters and nutrient had no consistent correlation between primary production throughout the mixed layer, which in the mud bank reaches to the bottom, due to the high rate of primary production (Pulle and Khan 2003).

The total primary organic production in an aquatic ecosystem is very often used for the assessment of the fishery resources. Estimation of primary production is generally done with phytoplankton community, through other autotrophic groups such as periphyton and macrophytes are present in varying quality in different environments. In shallow estuarine ecosystems like Achara, Mithbav, Deogad periphytic and sediment dwelling algae also
contribute significantly to the total primary production in addition to phytoplankton. Several studies (Qasim, 1973, 1979; Qasim et al., 1969, 1974; Nair et al., 1975; Gopinathan et al., 1984) were done on the primary production in Cochin estuary. Quasim (1973) estimated the gross production in the estuary to be 0.35 to 1.59 C/m²/day.

The gross and net primary productivity was calculated by several workers, carried out exhaustive studies on primary productivity in freshwater bodies. (Sreenivasan 1963, 1964; Quasim et al., 1969; Quasim; 1973, 1979; Comita, 1986; Babu Rao, 1997; Nair 1975; Ganapati and Pathak; 1978 Khan and Zutshi 1982; Gopinathan et al., 1984; Vass et al., 1988).

In the present study, the gross primary productivity (GPP) and net primary productivity (NPP) level in water was recorded higher in summer and lower level was reported in winter compared to other seasons. The high GPP and NPP were observed in summer due to the high photosynthetic rate, transparency and temperature. Similar results were observed by Atauri and de Lucio (2001), Chase and Leibold (2002), Fukami and Morin (2003) and Horner Devine (2003). The GPP and NPP were lower in monsoon due to the low temperature and low photosynthetic rate (Abrams, 1995; Waide et al., 1999; Gross, 2000; Mittlebach et al., 2001; Van Rensburg, 2002; Haddad et al., 2003).

In monsoon, there is continuous mixture of bottom and surface water, the sediment brought up and mixed with the photic zone, which increases the production. A direct correlation of primary productivity and nutrient was observed by, Wright (1964), Nair et al., (1975). Qasim et al., (1969, 1973, 1979), Gopinathan et al., (1984). Kumar (2005) reported that the primary production fully depends upon the availability of nutrients present in the habitat.

Increase in plant biomass over a period plus a loss during that period is the primary production. It has been used as potential index of productivity for many ecosystems of the world (Vass, 1997). Different ecosystems have different primary productivities depending
upon their physicochemical and biotic environments (Waide et al., 1999). The amount of energy available in a system (often measured as primary productivity) is through to be one of the major determinates of species diversity, especially species richness (Currie, 1991; Rosenzweig, 1999, Waide et al., 1999; Lennon et al., 2000). The predominant productivity richness relationship is unimodal (Rosenzweig and Abramsky, 1993; Tilman and Pacala, 1993; Abrams, 1995; Leibold, 1999; Waide, 1999), but other relationships have also been observed by Kaven and Bell, (1965). Variability in the functional from of the relationship between productivity and species richness is due to a number of factors, including taxonomy (Horner-Devine et al., 2003), community sequence (Fukami and Morin, 2003) and both the spatial scale (local Vs regional) and ecological scale (within Vs among communities), (Wadie et al., 1999; Gross et al., 2000; Wills and Whittaker, 2002). Chase and Leibold (2002) fond that both the producers and animals exhibited scale dependent productivity species is richness patterns in ponds. At the local scale, this relationship was positively linear. In addition, combining data for all species within a taxonomic group may mask patterns at finer taxonomic levels. Thus, a critical issue that has largely been ignored is variability in the relationship between productivity and species richness that may occur among functional guides or other ecologically-derived groups within a given taxon (Haddad et al., 2000; Horner-Devine et al., 2003).

Heterogeneity of environmental variables also can be a critical factor in determining the number of species in an area (Rosenzweig, 1995; Kerr and Packer, 1997; Hawkins and Porter, 2003). Environmental heterogeneity is positive correlated with species richness for a number of taxonomic groups, across multiple spatial scales (Atauri and De Lucio, 2001; Van Rensberg et al., 2002). The relationship between heterogeneity of primary productivity and species richness remains virtually unexplored, yet may be similarly correlated. Kerr et al., (2001) found that remotely sensed
heterogeneity data helped to explain species richness above and beyond influence of available energy. Vijayraghavan (1971) found the minimum values of the primary productivity 10 times greater than the minimum value in Othakadi pond, 4 times in Teppakulum tank and about 5 times in Yannamalai pond. Ganpati and Pathak (1978) found that the gross production in Sayaji Sarovar, Baroda varied between 0.442 mg/c/m$^3$/day and 7.46 mg/c/m$^3$/day in 1963 and 1.57 mg/c/m$^3$/day in 1964. Subbamma (1993) fond that the gross production values ranged from 385.50 mg/c/m$^3$/hour to 980 mg/c/m$^3$/hour and net production values ranged from 62.00 mg/c/m$^3$/hour to 390.85 mg/c/m$^3$/hours. Bohra (1997) found a high annual average production of 26 mg/c/m$^3$/day in Padam sagar and 24.3 mg/c/m$^3$/day in Rani sagar Lake near Jodhpur.

Gross (2000) stated that a smaller population under favorable conditions might have a high rate primary production, whereas a large population under favorable conditions may have low rate of primary productions. The trends of variations in primary production showed that, the production was high in summer and find relationship between the other parameter specially water temperature. The trends of gross production indicate peaks of phytoplankton abundance coinciding with monsoon as observed by Currie (1991) and Kerr and Packer (1997). Subbamma (1993) stressed that the population was high in summer and should be attributed to the prolonged day length and high intensity of light. Low primary production coincided with high level and increased turbidity as observed by Kerr and Packer (1997) in and identical situations. Primary productivity indirectly correlated with solar radiation and same direct relation was observed in the present study (Hawkins and Leibold, 1999; Mittlebach et. al., 2001; Porter, 2003; Horner-Devine, 2003).

Sumitra (1971) studied seasonal variation in primary productivity in the tropical ponds. She established a direct correlation between productivity and alkalinity values.
Ramkrishnaiah, and Sarkar (1982) worked on limnology, primary production of tropical lakes near Bihar (Konar reservoir), found fluctuation in chlorophyll, pH and dissolved oxygen and were interrelated. Nair (1975) reported very little variation in the primary production in lake water in a single year. Prasad and Nair (1967) carried out studies in the filed of primary productivity of coastal Meromictic Lake in Hukkaido. Marine primary production contributes to 10-50% of global photosynthetic production. Carbon fixation by phytoplankton helps to maintain steady state of atmospheric CO$_2$. Changes in ocean circulation results in increased primary productivity in low nutrient open ocean waters. Magnitude of marine primary productivity ranges from 20-55 Gt. of carbon/year (Gaarder and Gran, 1972). Vijayaraghvan (1971) and Datta et al., (1984) have reported significantly a positive relationship between temperature and primary production. The primary productivity values were low during monsoon period may attributed to the poor light conditions due to the cloudy sky and also the rain water. Similar observation reported by Shreekumar and Joshep (2001). Hutchinson (1975c) considered transparency as an index of primary productivity. According to Zutshi (1981) during monsoon, the nutrients are brought up to the surface water layer. Increased vertical stability of the water particularly in the post monsoon periods keeps the nutrient levels low in correlation of periphyton production with biomass standing crop, hydrographic parameters and nutrients had no consistent correlation between primary production values and hydrographic parameters. Increase in plant biomass over period plus losses during that time were the primary production. It has been used as potential index of productivity for many ecosystems of the world (Mathew, 1975).

The variations in the amount of productivity greatly differ from ponds to lakes to rivers to dams, depending on changing environmental conditions (Salaskar and Yeragi, 2004). The gross primary production of Achara creek was not uniform throughout the
year but varied from month to month and place to place (Yeragi and
late winter. Marry Ester (1983) found that the gross production
varied between 1.36 mg/c/m$^3$/day and 7.46 mg/c/m$^3$/day in
Banjara and Nadimi stations respectively.