

# Ground Water Quality Analysis of Water Sources in Industrial Area of West Zone of Central India

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**ABSTRACT:** In the present study we are intended to find out the diffuse chemical pollution in west Zone of Central India on the basis of industrial area. We have designed twenty sampling stations district for this study in west zones i.e. Gawaliar, Shivpuri, Ashok Nagar, Datiya, Muraina, Bhind, Guna, Tikamgarh, Vidisha, Raisen, Sihora, Rajgarh, Sajapur, Dewash, Ujjain, Ratlam, Indore, Khandawa, Burhanpur and Harda. Twenty sampling locations consisting of bore wells and hand pumps were selected in the study area. Sampling was done during summer, rainy and winter seasons (of year 2013 to 2014). Madhya Pradesh literally means 'central province' and is located in the geographic heart of India, between latitude 21.2°N-26.87°N and longitude 74°02'-82°49'E. Madhya Pradesh is the second largest state in the country by area. The results of the above work i.e. temperature, TDS, nitrate, sulphate and Phosphate are well within the permissible limit except some samples of pH, turbidity, total hardness, DO, BOD and COD in study area during study periods mostly exceeded the value of WHO.

**KEYWORDS:** Ground Water, Physico-Chemical Parameters, Statistical Analysis, Industrial Area, Central India.

## I. INTRODUCTION

The central India plateau is environmentally very important to understand the rich Indian biodiversity and diffuse chemical pollution. Madhya Pradesh literally means 'central province' and is located in the geographic heart of India, between latitude 21.2°N-26.87°N and longitude 74°02'-82°49'E. Madhya Pradesh is the second largest state in the country by area. It borders the state of Uttar Pradesh to the north-east, Chhattisgarh to the southeast, Maharashtra to the south, Gujarat to the west, and Rajasthan to the North West. The problems of ground water quality in several part of the country have become so acute in the areas that are densely populated and thickly industrialized and have shallow ground water tube wells<sup>[1-9]</sup>. There are many sources that contribute contaminants to the Ground water, e.g. land disposed of solid wastes, disposal on land, agricultural activities, and urban runoff and polluted surface water. In India, some investigation concerning hydrochemistry and chemical quality of ground water are on record<sup>[10]</sup>. Study of chemical budget of the major ions gain importance since it explains the origin of the ions in ground water and the level of the contamination by natural as well as anthropogenic sources<sup>[11]</sup>. Many researchers have focused on hydro chemical characteristics and contamination of ground water in different basins as well as in urban areas that resulted due to anthropogenic intervention and domestic waste water<sup>[12, 13]</sup>. Natural phenomena such as volcanoes, algae blooms, storms and earthquakes also cause major change in water quality and the ecological status of water<sup>[14]</sup>.

Water is one of the most vital resources for the sustenance of human, plants and other living beings. It is required in all aspects of life and health for producing food, agricultural activity for producing food, agricultural activity and energy generation. Water resources have played critical and vital role throughout history in the growth and context continue to be a factor of important in the economic growth of all the contemporary societies. Water is one of the most indispensable resources and is the elixir of life. Water constitutes about 70% of the body weight of almost all living organism. Life is not possible on this planet without water. It exists in three states namely solid, liquid and gas. It acts as a media for both chemical and biochemical reaction and also as a internal and external medium for several

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organisms. About 97.2% of water on earth is salty and only 2.8% is present as fresh water from which about 20 % constitutes ground water. Ground water is highly valued because of certain properties not possessed by surface water [15].

Global industrialization is a very important and critical issue in context of the present society. It is often extremely difficult, especially in developing countries, to handle the situation properly ensuring sustainable green environment and premature death. Many activities are known to cause contamination of solid, surface and ground water [16], that is why, is very important to possess the knowledge of the eco- toxicological properties of chemical or organic matters to maintain environmental stability [17]. Biodegradability is important parameters due to the simple fact that it allows to know the ecological behavior of substances and products. Information on the degradability of chemical may be used for hazard and risk assessment [18]. The rapid growth and proliferation of industrial sector have contributed to severe deleterious effect on the environment. Presently the ground water quality of Industrial area of west zone of central India has been assessed by analyzed including temperature, pH, turbidity, total hardness, TDS, DO, BOD, COD, nitrate sulphate and phosphate.

## II. MATERIAL AND METHODS

We assume Madhya Pradesh as a central India (study area) which is divided in to two zones (a) East Zone of Central India (b) west Zones of Central India. In the present study we are intended to find out the diffuse chemical pollution in west Zone of Central India on the basis of industrial area. We have designed twenty sampling stations district for this study in west zones i.e. Gawaliar, Shivpuri, Ashok Nagar, Datia, Muraina, Bhind, Guna, Tikamgarh, Vidisha, Raisen, Sihora, Rajgarh, Sajapur, Dewash, Ujjain, Ratlam, Indore, Khandawa, Burhanpur and Harda.

Twenty sampling locations consisting of bore wells and hand pumps were selected in the study area. Sampling was done during summer, rainy and winter seasons (of year 2013 to 2014). The month of April-May, July-August and December-January, were selected as representative month of summer, rainy and winter seasons respectively. Sampling was done in accordance with grab sampling methods in polyethylene bottles of one liter capacity. To avoid leaching of metals and interaction with the surface wall of the container, bottles were first cleaned with detergent and then with 1:1 HNO<sub>3</sub> for 24 hours. Finally bottles were cleaned and rinsed with the distilled water. During sampling bottles were rinsed two to three times with the sample to be examined before finally filling with it. Samples were collected by immersing the rinsed bottles in river water [19-20]. During sampling from hand pumps and bore wells, the water pumped to waste for about five minutes and sample was collected directly. All the samples were refrigerated at 4°C in the laboratory [19, 21, 22] and procedures were followed as per the standard methods [23] and different physicochemical parameters like, temperature, pH, turbidity, TDS hardness dissolved oxygen, BOD, COD, nitrate, sulphate and phosphate were analyzed. The location of sampling stations are shown in **table-1**

**Table-1:** Sampling location of Industrial Area of East Zone of Central India

S.N	Sampling location of Industrial Area of East Zone of Central India
1	I <sub>21</sub> = Near Taxtile Industry Gawalior
2	I <sub>22</sub> = Shivpuri Near Kattha Factory
3	I <sub>23</sub> = Near New Industrial Area Rawasar Tehsil, Ashok Nagar
4	I <sub>24</sub> = Datia Near Metal Industries Industrial Area ,Datia
5	I <sub>25</sub> = Muraina, Near Banmaor Cement Plant
6	I <sub>26</sub> = Bhind Near Cotton Textile Industry
7	I <sub>27</sub> = Near National Fertilizer Limited ,Guna.
8	I <sub>28</sub> = Tikamgarh, Near Plastics , Rubber Spectro Based Industry
9	I <sub>29</sub> = Near Kurwai Industrial area Vidisha
10	I <sub>30</sub> = Near Obedulaganj Industrial area Raisen
11	I <sub>31</sub> = Near Budani Industrial Area Sihore District.

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12	I <sub>32</sub> = Near Jut Mills Rajgarh.
13	I <sub>33</sub> = NearCauesting Foundry and Rerolling mills.
14	I <sub>34</sub> =Near renboxi Pharmaceutical industry Dewas
15	I <sub>35</sub> = Near Synthetic yarn industry Ujjain
16	I <sub>36</sub> =Drag and Pharmaceutical industry, Ratlam.
17	I <sub>37</sub> =Near Plastics industry, Indore.
18	I <sub>38</sub> =Near cotton mills Khandwa.
19	I <sub>39</sub> =Near Papers mills NepaNagar, Burhanpur.
20	I <sub>40</sub> =Eknath Solvent Extraction Gram Pidgoan, Harda.

### III. RESULT AND DISCUSSION

Temperature of ground water sample in Industrial area of west zone central India during monsoon seasons shows ranged from 25.6°C to 37.9°C, with mean temperature 30.2°C. Maximum temperature 37.9°C was observed at sampling station I<sub>25</sub> (Muraina near Banmaur Cement Plant) and minimum 25.6°C was found at sampling station I<sub>22</sub> (Shivpuri near Kattha Factory) as shown in **table- 1**. The pH of water samples ranges from 6.2 to 8.6 with mean of 7.4. PH of all the samples were below the permissible limit except two samples I<sub>27</sub> (8.6) and I<sub>37</sub> (8.5). Turbidity ranges from 0.3 to 12.8 NTU with mean of 2.8 NTU. Values of turbidity at sampling station I<sub>25</sub> (12.8) and I<sub>30</sub> (7.6) NTU are higher than the permissible limit prescribed by WHO [24]. Total hardness varied between 210.0 to 860.0 mg/L with mean of 488.0 mg/l. Values of total hardness at sampling station I<sub>21</sub> (846.0), I<sub>22</sub> (720.0), I<sub>25</sub> (624.0) I<sub>26</sub> (668.0) I<sub>27</sub> (860.0), and I<sub>30</sub> (660.0), mg/l are more than the permissible limit set by WHO. TDS ranges from 187.0 to 514 mg/l with mean value of 286.5 mg/l. The maximum TDS 514.0 mg/l was found at samples I<sub>37</sub> (Near plastics industry Indore) all the values of TDS found within the permissible limit except one location I<sub>37</sub>. DO values obtained from 1.4 to 7.6 mg/l with mean value of 3.8 mg/l. The minimum DO 1.4 was observed at sampling station I<sub>27</sub> (Near National Fertilizer limited, Guna). BOD values varied between 4.3 to 18.2 mg/l with mean value of 8.22 mg/l. twelve samples of BOD was found higher than the permissible limit prescribed by WHO as shown in **table-1**. Chemical oxygen values varied between 2.6 to 30.6 mg/l with mean value of 13.8 mg/l. Sixty percent samples had COD values more than the permissible limit prescribed by WHO. Nitrate of water samples ranges from 0.06 to 1.89 mg/l with mean value of 0.31 mg/l. nitrate values obtained from the stations in all samples were below the permissible limit set by WHO. Mean value of sulphate sand phosphates were found 85.90 and 0.062 mg/l respectively, all the samples of sulphate by WHO. The standard deviation value of temperature (2.94), pH (1.17), turbidity (3.11), DO (1.80), BOD (3.83), COD (7.7), nitrate (0.39), and phosphate (0.076), of each parameter between very little deviation, but in the case of total hardness (194.6), TDS (86.2) and sulphate (51.6) S.D. value have greater deviation together all the each parameters. The coefficient variation values of temperature (9.72) , pH (15.85), total hardness (39.89), TDS (30.09), DO (46.41) and BOD (46.61) showed wide fluctuations with each other with respect to relation of these parameters between stations, but in the vase of turbidity (108.8), COD (56.34), nitrates (124.1), sulphate (60.1) and phosphate (122.5) which was greater than the 50% coefficient variation, its indicate their significant coefficient variation between stations.

The correlation confidant (r) among various water quality parameters are given in **table-1a**. Temperature showed significant positive relationship with pH, turbidity, total hardness TDS, DO, COD, nitrate, sulphate and phosphate and negative relationship between BOD. PH showed significant positive relationship between temperature, pH, TDS, BOD, COD, nitrate, sulphate and phosphate and negative relationship with turbidity, total hardness and DO.

Turbidity showed positive relationship with temperature, turbidity, TH, TDS, DO, COD, nitrate and phosphate and negative relationship with pH, BOD and sulphate. Total hardness showed significant positive relationship between temperature, turbidity, total hardness ,TDS, BOD, COD, nitrate, sulphate and phosphate and negative relationship with PH and DO. TDS showed significant positive relationship with temperature, pH, turbidity, total hardness, TDS, BOD, COD and sulphate and negative relationship with DO, nitrate and phosphate.

Dissolved oxygen (DO) showed positive relationship between temperature, turbidity, DO, nitrate and phosphate and negative relationship with PH, TH, TDS, BOD, COD and sulphate. Biochemical oxygen demand (BOD) showed significant positive relationship with pH, total hardness, TDS, BOD, COD and sulphate and negative relationship with temperature turbidity, DO, nitrate and phosphate. Chemical oxygen demand (COD) showed

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significant negative relationship with DO and significant positive relationship with temperature, pH, turbidity, total hardness, TDS, BOD, COD, nitrate sulphate and phosphate.

Nitrate showed positive relationship with temperature, pH, turbidity, total hardness, DO, COD, nitrate, sulphate and phosphate and negative relationship with TDS and BOD. Sulphate showed negative relationship with turbidity, DO and phosphate and positive relationship with temperature, pH, total hardness, TDS, BOD, COD nitrate sulphate. Phosphate showed significant positive relationship with temperature PH, turbidity total hardness DO, COD, nitrate and phosphate and negative relationship with TDS, BOD, and sulphate.

The present study deals with the various relationship derived statistically by calculation 'r' and 't' among the physico-chemical characteristics, the r value was negative sixteen times and forty nine times this showed that positive relationship in the present study. During monsoon season, correlated different parameters each other statistically which shows great variation negative to positive values for 1% significant value (2.878) and 5% significant value (2.101). In the case of TDS and temperature, COD and hardness, nitrate and hardness, phosphate and hardness, BOD and TDS, COD and TDS, nitrate and DO, COD and BOD and sulphate and BOD we established a correlation ship which were positive and values were 2.332, 2.456, 2.720, 2.194, 2.221, 2.573, 2.475, 2.117 and 2.165 respectively, which was greater than 5% significant level. Turbidity and temperature, phosphate and turbidity we have found positive value of correlation ship at 1% significant level i.e. 3.002 and 4.058 while BOD and DO shows negative relationship i.e. 4.950 respectively with each other at 1% significant level. It Showed that TDS, temperature, COD, hardness, nitrate, phosphate, BOD, DO, sulphate, turbidity, play major role in the physico-chemical characteristics of ground water in Industrial area of west zone central India during monsoon season.

The temperature values of ground water in Industrial area of west zone Central India during winter seasons ranging from 17.4<sup>0</sup>C to 28.0<sup>0</sup>C, with a mean value 20.2<sup>0</sup>C. The maximum temperature 28.0<sup>0</sup>C was found sampling station I<sub>25</sub> (Muraina Near Banmaor cement plant). PH of all the water samples during winter season was found below the permissible limit 8.5 given by WHO standard. Values of 7.6. The maximum PH 8.3 was found at sampling station I<sub>37</sub> (Near Plastics Industry Indore). The turbidity of the given samples varied from 0.3 to 5.8 NTU, with a mean value 2.66 NTU. Turbidity of all the water samples was within the permissible limits accepts two sample I<sub>26</sub> (5.8) and (5.3) NTU. The total hardness of the ground water samples under test varied from 223.0 to 796 mg/l. Value of total hardness at sampling station I<sub>21</sub> (836.0) mg/l are more than the permissible limit set by WHO as 600 mg/l. TDS varies from 147.0 to 502 mg/l with an mean value of 273.5 mg/l and all the samples show concentration of TDS within the permissible level. The minimum concentrations of dissolved oxygen were 1.2 to 7.8 mg/l respectively. Whereas the maximum allowable limit for dissolve oxygen as per WHO guidelines is 4.0 mg/l. DO level in all studied samples only I<sub>24</sub> (4.7), I<sub>25</sub> (7.1), and I<sub>28</sub> (5.3) are more than compared WHO standard. Biochemical oxygen demand varies from 4.5 to 16.5 mg/l with a mean value 7.6 mg/l (**table-2**). Thirteen samples exceeded the permissible level of 6.0 mg/l as per WHO standard. chemical oxygen demand values in the ground water samples are varies from 2.3 to 33.4 mg/l with an mean value 12.8 mg/l Fifty percent samples BOD exceeded the permissible limit 10.0 mg/l as per WHO standard. In the case of nitrates, sulphate and phosphate, the mean value were observed as 0.34, 87.60 and 0.063 mg/l respectively WHO prescribed the desirable limit were recorded as 45, 250 and 0.3 mg/l which is safe range of drinking. The standard deviation value of temperature (2.98), pH (0.56), turbidity (2.60), DO (1.87), BOD (3.42), COD (7.94), nitrates (0.40) and phosphate (0.07) of each parameters between very deviations together all the each parameters, but in the case of total hardness (179.3), TDS (77.06) and sulphate (51.28) S.D. value have greater deviation together all the each parameters as show in **table-2**. The CV values of temperature (14.7), PH (7.48), total hardness (38.01), TDS (28.17), DO (46.28), BOD (44.82) showed wide fluctuations with each other with respect to relation of these parameters between station, but in the case of turbidity (97.86), COD (61.66), nitrates (117.20), sulphate (58.54) and phosphate (123.8) which was greater than the 50% significant coefficient variation between station.

The correlation coefficient (r) among various water quality parameters are given in **table-2a**. Temperature showed significant positive relationship with PH, turbidity, total hardness, TDS, DO, BOD, COD, nitrate, sulphate and phosphate and negative relationship are not found in each other parameters. PH showed significant positive relationship with temperature, pH, TDS, DO, BOD, COD, nitrate and sulphate and negative relationship with pH, total hardness and phosphate.

Turbidity showed relationship between temperature, turbidity, total hardness, TDS, DO, COD, nitrate, sulphate and phosphate and negative relationship with pH and BOD. Total hardness showed significant positive relationship with

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temperature, turbidity, total hardness, BOD, COD, nitrate, sulphate and phosphate and negative relationship with pH, TDS and DO. TDS showed significant positive relationship with temperature, pH, turbidity, TDS, BOD, COD and sulphate and negative relationship with total hardness, DO, nitrate and phosphate.

Dissolved oxygen (DO) showed positive relationship with temperature, pH, turbidity, DO, nitrate and phosphate and negative relationship with total hardness, TDS, BOD, COD and sulphate. Biochemical oxygen demand (BOD) showed significant positive relationship with temperature, pH, total hardness, TDS, BOD, COD and sulphate and negative relationship with turbidity, DO, nitrate and phosphate. Chemical oxygen demand (COD) showed positive relationship with temperature, pH, turbidity, total hardness, TDS, BOD, COD, nitrate, sulphate and phosphate and negative relationship with DO.

Nitrate showed positive relationship with temperature pH, turbidity, total hardness, DO, COD, nitrate sulphate and phosphate and negative relationship with TDS and BOD. Sulphate showed negative relationship with DO and phosphate and positive relationship with temperature, pH, turbidity, total hardness, TDS, BOD, COD, nitrate and sulphate. Phosphate showed significant positive relationship between temperature, turbidity, total hardness, DO, COD, nitrate and phosphate and negative relationship with pH, TDS, BOD and sulphate.

The various relationships derived statistically by calculation  $r$  and  $t$  among the physico-chemical characteristic. The  $r$  value was fifteen times negative and fifty times positive this showed that positive relationship in the present study. During winter season, we have investigated the different physico-chemical characteristics of ground water in Industrial area of west zone central India and stabilized the correlation by using ANOVA statistical software. The table values of 5% significant level were 2.101 and at 1% significant level were 2.878. In the case of turbidity and temperature, phosphate and temperature, nitrate, and hardness, nitrate and DO, COD and BOD, sulphate and COD we established a correlation ship which were positive and value were 2.793, 2.118, 2.512, 2.366, 2.494 and 2.400 respectively, which was greater than 5% significant level. Phosphate and turbidity we have found positive value of correlation at 1% significant level i.e. 3.157. For BOD and DO we have found  $-4.737$  shows negative correlation which was more than 1% significant level. It showed that turbidity, temperature, phosphate, nitrate hardness, DO, COD, BOD, sulphate play major role in the physico-chemical characteristics of ground water in Industrial area of west zone central India during winter season.

The temperature of ground water in industrial area of west zone central India was found ranged between  $29.0^{\circ}\text{C}$  to  $40.0^{\circ}\text{C}$  with a mean temperature of  $32.4^{\circ}\text{C}$ . The Maximum temperature was recorded at sampling station  $I_{25}$  (Muraina, Near Banmaor Cement plant) while minimum was recorded at sampling station  $I_{35}$  (Near synthetic yarn Industry uja). The PH of the ground water in the study area is 6.6 to 8.4 with mean values of 7.77. The PH of all the water samples was within the permissible limit prescribed by WHO standards as 8.5; the water is slightly all alkaline in nature and can be considered for most of the uses. Turbidity of the given samples varied from 0.6 to 6.4 NTU with a mean value of 3.0 NTU. The maximum turbidity was obtained 6.4 NTU at sampling station  $I_{26}$  (Bhind Near Cotton Textile Industry). All the samples are within the permissible limit except two samples  $I_{26}$  (6.4) and  $I_{30}$  (5.8 NTU). During the investigation period total hardness varied from 245.0 mg/l to 821.0 mg/l. The maximum hardness 821.0 mg/l was observed at sampling station  $I_{21}$  (Near Textile Industry Gwalior). Values of total hardness at sampling station  $I_{21}$  (821.0),  $I_{22}$  (724.0),  $I_{25}$  (634.0),  $I_{26}$  (685.0) and  $I_{30}$  (620) mg/l are higher than the permissible limit prescribed by WHO. TDS level in ground water is 162.0 to 508 mg/l which is below the permissible limit except one samples  $I_{37}$  (508) mg/l. DO values varied from 1.0 to 8.0 mg/l with an mean value of 4.28 mg/l. Sixty percent samples showed high DO values. In the present study BOD varied from 4.0 to 16.0 mg/l with an mean value of 7.41 mg/l the maximum BOD 16.2 mg/l was found at sampling station  $I_{27}$  (Near National Fertilizer Limited, Guna). Twelve samples exceeded the permissible level of 6.0 mg/l as per WHO standard. Chemical oxygen Demand values varied between 2.0mg/l to 36.7 mg/l with an mean value of 12.4 mg/l. Maximum COD 12.4 mg/l was found at sampling station  $I_{27}$ . COD values at sampling station  $I_{21}$  (23.5),  $I_{25}$  (15.6),  $I_{27}$  (36.7),  $I_{29}$  (21.2),  $I_{34}$  (25.6),  $I_{37}$  (19.5),  $I_{38}$  (11.6) and  $I_{40}$  (16.7), and mg/l are higher than the permissible limit as given in table-39. Nitrate concentration ranged from 0.09 to 1.94 mg/l. All water samples show nitrates within permissible limit. The concentration of sulphate 18.0 to 189.0 mg/l 189.0 mg/l. Sulphate 189.0 was found at sampling station  $I_{37}$  (Near Plastics Industrial Indore). All the samples of sulphate concentration were below the permissible limit. The concentration of phosphate ranged from 0.004 to 0.255 mg/l with a mean value of 0.054 mg/l. All water samples show phosphate within permissible limits as show **table-39**. The standard deviation value of temperature (2.81), PH (0.56), turbidity (2.75), (2.0), BOD (3.7), COD (8.8), nitrates (0.40) and phosphate

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(0.070) of each parameters between very little deviation together all the each parameters, but in the case of total hardness (186.14), TDS (84.39) and sulphate (51.37) S.D. value have greater deviation together all the each parameters as shown in **table- 3**. The CV values of temperature (8.67), PH (7.20), total hardness (37.5), TDS (28.8), (DO) (46.9) and sulphate (5.7) showed wide fluctuations with each other with respect to relation of these parameters between station but, the case of turbidity (91.5), BOD (51.03), COD (71.25), nitrate (107.2) and phosphate (129.6) which was greater than the 50% coefficient variation its indicates their significant variation between stations.

The correlation coefficients (r) among various water quality parameters are given **table-3a**. The temperature of ground water in study area during summer showed significant positive relationship with PH, turbidity, total hardness, TDS, DO, BOD, COD, nitrate, sulphate and phosphate and negative relationship are not found in given eleven parameters. PH showed positive relationship with temperature, pH, TDS, DO, BOD COD, nitrate sulphate and phosphate and negative relationship between turbidity and total hardness.

Turbidity showed significant positive relationship with temperature, turbidity, total hardness, TDS, DO, COD, nitrate, sulphate and phosphate and negative relationship with pH and BOD. Total hardness showed positive relationship with temperature, turbidity total and hardness, TDS, BOD, COD, nitrate, sulphate and phosphate and negative relationship with pH and DO. Total dissolve solid (TDS) showed significant positive relationship with temperature, pH, turbidity, total hardness, TDS, BOD, COD, sulphate and phosphate and negative relationship with DO and nitrate.

Dissolved oxygen (DO) showed negative relationship with TH, TDS, BOD, COD and sulphate and significant positive relationship showed temperature, pH, turbidity, DO, nitrate and phosphate. Biochemical oxygen demand (BOD) showed significant positive relationship with temperature, pH, TH, TDS, BOD, COD, and sulphate and negative relationship with turbidity, DO, nitrate and phosphate. Chemical oxygen demand (COD) showed significant positive relationship with temperature, pH, turbidity, total hardness, TDS, BOD, COD, nitrate, sulphate and phosphate and negative relationship with DO.

Nitrate showed significant positive relationship with temperature, pH, turbidity, total hardness, DO, BOD, COD, nitrate, sulphate and phosphate and negative relationship with TDS and DO. Sulphate in the present investigation showed positive relationship with temperature, pH, turbidity, total hardness, TDS, BOD, COD, nitrate and sulphate and negative relationship with DO and phosphate. Phosphate showed significant positive relationship with temperature, pH, turbidity, total hardness, TDS, DO, COD, nitrate and phosphate and negative relationship with BOD and sulphate.

The present study deals with the various relationship derived statically by calculation r and t among the physico-chemical characteristics. The r value was negative twelve times and positive fifty four times, this showed that positive relationship in the present ground water studied. During summer seasons, correlated different parameters each other statically which shows great variation negative to positive for 5% significant level (2.101) and 1% significant value (2.878). In the case of phosphate and turbidity, COD and hardness, nitrate and hardness, BOD and TDS, COD and TDS, phosphate and DO, sulphate and COD and phosphate and nitrate i.e. 2.667, 2.112, 2.405, 2.391, 2.806, 2.296, 2.294 and 2.474, we established a correlation with each other at 5% significant level. Turbidity and temperature and COD and BOD we have found 3.731 and 3.338 respectively showed positive correlation ship which were greater than 1% significant level while BOD and DO we have found negative value of correlation ship at 1% significant level i.e. -5.303. It showed that phosphate, turbidity, COD, hardness, nitrate, BOD, TDS, COD, DO, sulphate, temperature play major role in the physico-chemical characteristics of ground water in Industrial area of west zone central India during summer seasons.

The average physico-chemical Characteristics of ground water in Industrial area of west zone central India are presented in **table- 4**. The variation of temperature in the study area was observed to be 23.9<sup>0</sup>C minimum to 35.3<sup>0</sup>C maximum. PH was ranging from 6.47 to 8.40, the turbidity was found ranged between 0.47 to 11.93 NTU and total hardness was ranged between 229.3 to 856.3 mg/l. TDS values varied between 192.0 to 508 mg/l. Dissolved oxygen was found ranged between 1.20 to 7.8 mg/l. BOD and COD were in the range of 4.23- 16.3, 2.30- 33.57 mg/l respectively. In the case of nitrate, sulphate and phosphate, the values were ranged between 0.06 14.33 and 0.0030 to 1.92, 192.67 and 0.251 mg/l respectively as shown in **table-4**.

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**Table-1: Physico -chemical characteristics of Ground water in Industrial area of West Zone Central India During Monsoon Season.**

Parameters	Sampling Location																				Mean	S.D	C.V
	I <sub>21</sub>	I <sub>22</sub>	I <sub>23</sub>	I <sub>24</sub>	I <sub>25</sub>	I <sub>26</sub>	I <sub>27</sub>	I <sub>28</sub>	I <sub>29</sub>	I <sub>30</sub>	I <sub>31</sub>	I <sub>32</sub>	I <sub>33</sub>	I <sub>34</sub>	I <sub>35</sub>	I <sub>36</sub>	I <sub>37</sub>	I <sub>38</sub>	I <sub>39</sub>	I <sub>40</sub>			
Temperature	31.0	25.6	28.4	26.5	37.9	30.0	33.0	29.2	28.5	31.6	27.2	35.2	29.5	30.0	28.2	33.0	31.0	30.0	31.0	28.0	30.240	2.940	9.72
pH	8.3	6.2	8.5	7.2	7.8	3.5	8.6	7.8	7.3	6.7	7.5	8.1	7.9	8.4	7.8	8.1	8.5	6.8	6.2	7.4	7.430	1.178	15.85
Turbidity	4.0	1.0	0.5	0.8	12.8	6.1	3.4	0.6	4.8	7.6	3.9	1.2	0.4	0.7	1.0	1.5	2.6	1.4	2.6	0.3	2.860	3.114	108.88
Hardness	846	720	530	500	624	668	860	496	530	660	210	248	312	450	370	350	484	256	382	264	488.000	194.681	39.89
TDS	241	187	245	286	356	267	452	236	255	198	225	368	216	320	212	220	514	288	360	285	286.550	86.244	30.09
DO	7.6	3.6	3.2	4.3	6.8	3.4	1.4	5.0	2.4	1.8	3.8	3.0	5.4	1.6	3.5	5.2	1.2	4.2	6.6	3.9	3.895	1.808	46.41
BOD	5.0	10	9.2	8.2	5.5	6.8	13.8	9.2	6.2	11.8	6.8	6.0	7.3	15.0	6.9	4.5	18.2	5.0	4.3	4.8	8.225	3.834	46.61
COD	28.0	12.0	6.6	2.6	21.3	8.0	30.6	14.0	16.6	10.0	14.6	8.6	7.8	22.0	9.3	6.8	25.0	14.1	7.6	10.7	13.810	7.781	56.34
Nitrate	1.89	0.43	0.24	0.17	0.57	0.38	0.13	0.33	0.45	0.14	0.18	0.26	0.06	0.12	0.03	0.19	0.34	0.09	0.23	0.15	0.319	0.396	124.13
Sulphate	170	075	071	032	028	088	095	030	139	089	024	071	069	166	092	126	196	060	087	010	85.900	51.640	60.11
Phosphate	0.138	0.026	0.031	0.056	0.249	0.047	0.023	0.201	0.087	0.216	0.016	0.025	0.018	0.021	0.005	0.024	0.030	0.003	0.013	0.002	0.062	0.076	122.58

**All the Values except Temperature, pH and Turbidity expressed in mg/l**

**Industrial Area-** I<sub>21</sub>= Near Taxtile Industry Gawalior, I<sub>22</sub>= Shivpuri Near Kattha Factory, I<sub>23</sub>= Near New Industrial Area Rawasar Tehsil,Ashok Nagar, I<sub>24</sub>= Datia Near Metal Industries Industrial Area ,Datia, I<sub>25</sub> = Muraina, Near Banmaor Cement Plant, I<sub>26</sub>= Bhind Near Cotton Textile Industry, I<sub>27</sub>= Near National Fertilizer Limited ,Guna, I<sub>28</sub>= Tikamgarh, Near Plastics , Rubber Spectro Based Industry, I<sub>29</sub>= Near Kurwai Industrial area Vidisha, I<sub>30</sub>= Near Obedulaganj Industrial area Raisen, I<sub>31</sub>= Near Budani Industrial Area Sihore District, I<sub>32</sub>= Near Jut Mills Rajgarh, I<sub>33</sub>= NearCausting Foundry and Rerolling mills, I<sub>34</sub>=Near renboxi Pharmaceutical industry Dewas, I<sub>35</sub>= Near

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Synthetic yarn industry Ujjain, I<sub>36</sub>=Drag and Pharmaceutical industry, Ratlam, I<sub>37</sub>=Near Plastics industry Indore, I<sub>38</sub>=Near cotton mills Khandwa, I<sub>39</sub>=Near Papers mills NepaNagar, Burhanpur, I<sub>40</sub>=Eknath Solvent Extraction Gram Pidgoan, Harda.

Parameters	Temperature	pH	Turbidity	Hardness	TDS	DO	BOD	COD	Nitrate	Sulphate	Phosphate
Temperature	1										
pH	0.225 0.981	1									
Turbidity	0.578 3.002**	-0.238 -1.040	1								
Hardness	0.127 0.542	-0.101 -0.429	0.420 1.964	1							
TDS	0.482 2.332*	0.266 1.172	0.125 0.533	0.086 0.365	1						
DO	0.175 0.753	-0.070 -0.296	0.162 0.696	-0.033 -0.140	-0.289 -1.281	1					
BOD	-0.058 -0.244	0.284 1.257	-0.079 -0.334	0.330 1.182	0.464 2.221*	-0.724 -4.950**	1				
COD	0.331 1.489	0.414 1.926	0.308 1.375	0.501 2.456*	0.519 2.573*	-0.139 -0.595	0.452 2.117*	1			
Nitrate	0.148 0.633	0.074 0.313	0.280 1.238	0.540 2.720*	-0.061 -0.258	0.504 2.475*	-0.198 -0.853	0.467 2.237*	1		
Sulphate	0.125 0.535	0.220 0.954	-0.030 -0.126	0.322 1.440	0.293 1.298	-0.270 -1.188	0.455 2.165*	0.483 2.341*	0.365 1.661	1	
Phosphate	0.411 1.910	0.016 0.066	0.691 4.056**	0.459 2.194*	-0.126 -0.538	0.277 1.223	-0.002 -9.502	0.222 0.963	0.394 1.817	-0.108 -0.462	1

**Table -1a Correlation coefficient (r) among various water quality parameters  
(Physico -chemical characteristics of Ground water in Industrial area of West Zone Central India  
During Monsoon Season).**



**Table- 2: Chemical characteristics of Ground water in Industrial area of West Zone Central India During Winter Season**

Parameters	Sampling Location																						
	I <sub>21</sub>	I <sub>22</sub>	I <sub>23</sub>	I <sub>24</sub>	I <sub>25</sub>	I <sub>26</sub>	I <sub>27</sub>	I <sub>28</sub>	I <sub>29</sub>	I <sub>30</sub>	I <sub>31</sub>	I <sub>32</sub>	I <sub>33</sub>	I <sub>34</sub>	I <sub>35</sub>	I <sub>36</sub>	I <sub>37</sub>	I <sub>38</sub>	I <sub>39</sub>	I <sub>40</sub>	Mean	S.D	C.V
Temperature	23	18.2	22.5	19.6	28	20	22	17.4	19	21.4	18.6	23	21.3	23	14.5	19	21.5	18	17.5	17	20.225	2.989	14.77
pH	8.1	6.5	8	7.4	7.9	6.7	7.6	7.5	7.8	6.6	8	7.8	8.2	8	7.8	8	8.3	6.6	7.4	7.9	7.605	0.569	7.48
Turbidity	3	0.8	1.2	0.8	11	5.8	2	0.5	5	5.3	4.2	1.6	0.7	1	0.6	2	2.9	1.2	3.4	0.3	2.665	2.608	97.86
Hardness	796	684	534	422	588	679	836	453	486	590	233	236	322	429	376	309	495	272	413	285	471.900	179.396	38.01
TDS	221	214	234	272	364	147	320	250	244	213	235	338	246	301	200	233	502	294	354	289	273.550	77.067	28.17
DO	7.8	3.9	3.5	4.7	7.1	3.6	1.2	5.3	2.3	1.6	4	3.4	5.6	1.7	3.8	5.4	1.3	4.5	6.5	4	4.060	1.879	46.28
BOD	4.6	8	8.4	7.5	5	6.5	14.6	8.7	6.8	10.2	6.3	5.4	7	12.4	6.2	4.2	16.5	4.8	4.5	5	7.630	3.420	44.82
COD	26.2	9.5	5.5	2.3	17	6.2	33.4	11.4	18.5	8.6	12.5	6.9	7.4	20.2	8.4	6.2	23	13.2	8.3	12.8	12.875	7.940	61.66
Nitrate	1.93	0.48	0.18	0.2	0.6	0.42	0.15	0.3	0.48	0.13	0.22	0.34	0.07	0.15	0.05	0.24	0.37	0.13	0.23	0.18	0.343	0.402	117.20
Sulphate	175	78	74	28	34	90	98	27	135	91	28	73	67	169	94	130	193	64	89	15	87.600	51.288	58.54
Phosphate	0.14	0.027	0.033	0.054	0.251	0.049	0.025	0.211	0.085	0.218	0.014	0.026	0.016	0.022	0.006	0.023	0.032	0.003	0.014	0.002	0.063	0.078	123.80

All the Values except Temperature, pH and Turbidity expressed in mg/l.

**Industrial Area-** I<sub>21</sub>= Near Taxtile Industry Gawalior, I<sub>22</sub>= Shivpuri Near Kattha Factory, I<sub>23</sub>= Near New Industrial Area Rawasar Tehsil, Ashok Nagar, I<sub>24</sub>= Datia Near Metal Industries Industrial Area ,Datia, I<sub>25</sub> = Muraina, Near Banmaor Cement Plant, I<sub>26</sub>= Bhind Near Cotton Textile Industry, I<sub>27</sub>= Near National Fertilizer Limited ,Guna, I<sub>28</sub>= Tikamgarh, Near Plastics , Rubber Spectro Based Industry, I<sub>29</sub>= Near Kurwai Industrial area Vidisha, I<sub>30</sub>= Near Obedulaganj Industrial area Raisen, I<sub>31</sub>= Near Budani

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Industrial Area Sihore District, I<sub>32</sub>= Near Jut Mills Rajgarh, I<sub>33</sub>= NearCausting Foundry and Rerolling mills, I<sub>34</sub>=Near renboxi Pharmaceutical industry Dewas, I<sub>35</sub>= Near Synthetic yarn industry Ujjain, I<sub>36</sub>=Drag and Pharmaceutical industry, Ratlam, I<sub>37</sub>=Near Plastics industry Indore, I<sub>38</sub>=Near cotton mills Khandwa, I<sub>39</sub>=Near Papers mills NepaNagar, Burhanpur, I<sub>40</sub>=Eknath Solvent Extraction Gram Pidgoan, Harda.

**Table -2a Correlation coefficient (r) among various water quality parameters (Physico -chemical characteristics of Ground water in Industrial area of West Zone Central India During Winter Season**

Parameters	Temperature	pH	Turbidity	Hardness	TDS	DO	BOD	COD	Nitrate	Sulphate	Phosphate
Temperature	1										
pH	0.271 1.195	1									
Turbidity	0.550 2.793*	-0.057 -0.243	1								
Hardness	0.369 1.683	-0.239 -1.038	0.307 1.368	1							
TDS	0.335 1.509	0.373 1.705	0.107 0.456	-0.129 -0.550	1						
DO	0.054 0.227	0.120 0.512	0.167 0.716	-0.070 -0.297	-0.146 -0.627	1					
BOD	0.213 0.925	0.096 0.411	-0.125 -0.533	0.369 1.681	0.430 2.022	-0.745 -4.737**	1				
COD	0.339 1.530	0.288 1.276	0.160 0.687	0.511 2.519*	0.399 1.845	-0.230 -1.000	0.507 2.494*	1			
Nitrate	0.337 1.527	0.155 0.666	0.257 1.126	0.510 2.512*	-0.081 -0.345	0.487 2.366*	-0.224 -0.977	0.406 1.883	1		
Sulphate	0.198 0.854	0.255 1.120	0.001 0.004	0.338 1.523	0.217 0.944	-0.280 -1.235	0.417 1.948	0.493 2.400*	0.387 1.779	1	
Phosphate	0.446 2.118*	-0.116 -0.496	0.597 3.157**	0.391 1.802	-0.043 -0.183	0.256 1.124	-0.013 -0.054	0.120 0.513	0.365 1.664	-0.110 -0.470	1

1% Level of significance =\*\*

5% Level of significance =\*

**Table- 3: Chemical characteristics of Ground water in Industrial area of West Zone Central India During Summer Season**

Parameters	Sampling Location																						
	I <sub>21</sub>	I <sub>22</sub>	I <sub>23</sub>	I <sub>24</sub>	I <sub>25</sub>	I <sub>26</sub>	I <sub>27</sub>	I <sub>28</sub>	I <sub>29</sub>	I <sub>30</sub>	I <sub>31</sub>	I <sub>32</sub>	I <sub>33</sub>	I <sub>34</sub>	I <sub>35</sub>	I <sub>36</sub>	I <sub>37</sub>	I <sub>38</sub>	I <sub>39</sub>	I <sub>40</sub>	Mean	S.D	C.V
Temperature	32	28.5	30	29.8	40	33.2	34	30	31	34.7	30.6	36	32.8	33.4	29	35.7	34	32	31.8	30	32.425	2.814	8.67
pH	8.4	6.7	8.2	7.5	8	6.9	7.8	8	7.9	6.6	8.1	8	8.2	7.9	8.3	8	8.4	6.9	7.7	8	7.775	0.560	7.20
Turbidity	3.6	0.9	1.7	1	12	6.4	2.6	0.7	4.9	5.8	4.4	1.9	0.6	1.6	1.2	2.3	3.2	1	3.5	0.8	3.005	2.750	91.51
Hardness	821	724	553	482	634	685	873	483	538	620	245	249	330	439	384	344	510	275	427	299	495.750	186.142	37.54
TDS	256	205	251	293	376	162	459	243	267	219	240	346	260	314	247	239	508	297	369	293	292.200	84.392	28.88
DO	8	4.1	3.8	4.9	7.5	4	1	5.8	2	1.5	4.3	3.9	5.7	1.5	4.3	5.8	1.6	5	6.7	4.2	4.280	2.009	46.93
BOD	4.3	6.5	7.8	7.1	4.5	6	16.2	8.2	7.9	9.8	5.7	4.7	6.6	15.6	5.8	4	14.3	4	4.2	5.1	7.415	3.784	51.03
COD	23.5	7.2	5	2	15.6	5.6	36.7	9.6	21.2	6.7	9.8	5.7	6.8	25.6	7.8	5.4	19.5	11.6	7.4	16.7	12.470	8.885	71.25
Nitrate	1.94	0.52	0.16	0.22	0.73	0.46	0.17	0.27	0.49	0.1	0.26	0.35	0.09	0.19	0.11	0.31	0.4	0.17	0.3	0.23	0.374	0.403	107.75
Sulphate	181	78	75	25	40	94	105	24	132	92	32	75	65	172	96	134	189	67	91	18	89.250	51.378	5.75
Phosphate	0.143	0.029	0.034	0.051	0.255	0.05	0.027	0.214	0.083	0.021	0.012	0.028	0.014	0.022	0.007	0.02	0.034	0.004	0.017	0.005	0.054	0.070	129.62

All the Values except Temperature, pH and Turbidity expressed in mg/l.

**Industrial Area-** I<sub>21</sub>= Near Textile Industry Gawalior, I<sub>22</sub>= Shivpuri Near Kattha Factory, I<sub>23</sub>= Near New Industrial Area Rawasar Tehsil, Ashok Nagar, I<sub>24</sub>= Datia Near Metal Industries Industrial Area, Datia, I<sub>25</sub>= Muraina, Near Banmaor Cement Plant, I<sub>26</sub>= Bhind Near Cotton Textile Industry, I<sub>27</sub>= Near National Fertilizer Limited, Guna, I<sub>28</sub>= Tikamgarh, Near Plastics, Rubber Spectro Based Industry, I<sub>29</sub>= Near Kurwai Industrial area Vidisha, I<sub>30</sub>= Near Obedulaganj Industrial area Raisen, I<sub>31</sub>= Near Budani Industrial Area Sihore District, I<sub>32</sub>= Near Jut Mills Rajgarh, I<sub>33</sub>= Near Causting Foundry and Rerolling mills, I<sub>34</sub>= Near renboxi Pharmaceutical industry Dewas, I<sub>35</sub>= Near

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**Table -3a: Correlation coefficient (r) among various water quality parameters  
(Physico -chemical characteristics of Ground water in Industrial area of West Zone Central India  
During Summer Season**

Parameters	Temperature	pH	Turbidity	Hardness	TDS	DO	BOD	COD	Nitrate	Sulphate	Phosphate
Temperature	1										
pH	0.054 0.227	1									
Turbidity	0.660 3.731**	-0.090 -0.385	1								
Hardness	0.089 0.378	-0.216 -0.936	0.351 1.588	1							
TDS	0.400 1.852	0.374 1.710	0.096 0.407	0.067 0.292	1						
DO	0.060 0.253	0.205 0.888	0.143 0.610	-0.105 -0.446	-0.233 -1.018	1					
BOD	0.068 0.287	0.060 0.256	-0.104 -0.442	0.355 1.611	0.491 2.391*	-0.781 -5.303**	1				
COD	0.185 0.800	0.276 1.218	0.117 0.497	0.446 2.111*	0.552 2.806*	-0.358 -1.628	0.622 3.338**	1			
Nitrate	0.123 0.524	0.213 0.925	0.309 1.379	0.493 2.405*	-0.046 -0.196	0.492 2.394*	-0.262 -1.152	0.289 1.279	1		
Sulphate	0.202 0.873	0.203 0.880	0.033 0.138	0.331 1.490	0.263 1.154	-0.291 -1.296	0.429 2.011	0.476 2.294*	0.398 1.842	1	
Phosphate	0.323 1.449	0.204 0.882	0.532 2.667*	0.376 1.719	0.039 0.164	0.476 2.296*	-0.129 -5.550	0.146 0.624	0.504 2.474*	-0.131 -5.558	1

1% Level of significance =\*\*

5% Level of significance =\*

**Table 4: Average Physico -chemical characteristics of Ground water in Industrial area of West Zone Central India**

Parameters	Sampling Location																		
	I <sub>21</sub>	I <sub>22</sub>	I <sub>23</sub>	I <sub>24</sub>	I <sub>25</sub>	I <sub>26</sub>	I <sub>27</sub>	I <sub>28</sub>	I <sub>29</sub>	I <sub>30</sub>	I <sub>31</sub>	I <sub>32</sub>	I <sub>33</sub>	I <sub>34</sub>	I <sub>35</sub>	I <sub>36</sub>	I <sub>37</sub>	I <sub>38</sub>	I <sub>39</sub>
Temperature	28.67	24.10	26.97	25.30	35.30	27.73	29.67	25.53	26.17	29.23	25.47	31.40	27.87	28.80	23.90	29.23	28.83	26.67	26.67
SD (±)	4.93	5.31	3.95	5.20	6.41	6.89	6.66	7.06	6.33	6.96	6.18	7.29	5.92	5.30	8.15	8.96	6.53	7.57	8.15
pH	8.27	6.47	8.23	7.37	7.90	5.70	8.00	7.77	7.67	6.63	7.87	7.97	8.10	8.10	7.97	8.03	8.40	6.77	7.97
SD(±)	0.15	0.25	0.25	0.15	0.10	1.91	0.53	0.25	0.32	0.06	0.32	0.15	0.17	0.26	0.29	0.06	0.10	0.15	0.15
Turbidity	3.53	0.90	1.13	0.87	11.93	6.10	2.67	0.60	4.90	6.23	4.17	1.57	0.57	1.10	0.93	1.93	2.90	1.20	3.53
SD(±)	0.50	0.10	0.60	0.12	0.90	0.30	0.70	0.10	0.10	1.21	0.25	0.35	0.15	0.46	0.31	0.40	0.30	0.20	0.50
Hardness	821.00	709.33	539.00	468.00	615.33	677.33	856.33	477.33	518.00	623.33	229.33	244.33	321.33	439.33	376.67	334.33	496.33	267.67	407.33
SD(±)	25.00	22.03	12.29	40.84	24.19	8.62	18.77	22.05	28.00	35.12	17.79	7.23	9.02	10.50	7.02	22.14	13.05	10.21	23.03
TDS	239.33	202.00	243.33	283.67	365.33	192.00	410.33	243.00	255.33	210.00	233.33	350.67	240.67	311.67	219.67	230.67	508.00	293.00	361.67
SD(±)	17.56	13.75	8.62	10.69	10.07	65.38	78.31	7.00	11.50	10.82	7.64	15.53	22.48	9.71	24.42	9.71	6.00	4.58	7.56
DO	7.80	3.87	3.50	4.63	7.13	3.67	1.20	5.37	2.23	1.63	4.03	3.43	5.57	1.60	3.87	5.47	1.37	4.57	6.77
SD(±)	0.20	0.25	0.30	0.31	0.35	0.31	0.20	0.40	0.21	0.15	0.25	0.45	0.15	0.10	0.40	0.31	0.21	0.40	0.20
BOD	4.63	8.17	8.47	7.60	5.00	6.43	14.87	8.70	6.97	10.60	6.27	5.37	6.97	14.33	6.30	4.23	16.33	4.60	4.63
SD(±)	0.35	1.76	0.70	0.56	0.50	0.40	1.22	0.50	0.86	1.06	0.55	0.65	0.35	1.70	0.56	0.25	1.96	0.53	0.35
COD	25.90	9.57	5.70	2.30	17.97	6.60	33.57	11.67	18.77	8.43	12.30	7.07	7.33	22.60	8.50	6.13	22.50	12.97	7.07
SD(±)	2.26	2.40	0.82	0.30	2.97	1.25	3.05	2.21	2.31	1.66	2.41	1.46	0.50	2.75	0.75	0.70	2.78	1.27	2.26
Nitrates	1.92	0.48	0.19	0.20	0.63	0.42	0.15	0.30	0.47	0.12	0.22	0.32	0.07	0.15	0.06	0.25	0.37	0.13	0.19
SD(±)	0.03	0.05	0.04	0.03	0.09	0.04	0.02	0.03	0.02	0.02	0.04	0.05	0.02	0.04	0.04	0.06	0.03	0.04	0.03
Sulfates	175.33	77.00	73.33	28.33	34.00	90.67	99.33	27.00	135.33	90.67	28.00	73.00	67.00	169.00	94.00	130.00	192.67	63.67	89.33
SD(±)	5.51	1.73	2.08	3.51	6.00	3.06	5.13	3.00	3.51	1.53	4.00	2.00	2.00	3.00	2.00	4.00	3.51	3.51	5.51
Phosphates	0.1403	0.0273	0.0327	0.0537	0.2517	0.0487	0.0250	0.2087	0.0850	0.1517	0.0140	0.0263	0.0160	0.0217	0.0060	0.0223	0.0320	0.0033	0.0140



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SD(±)	0.002517	0.0015	0.0015	0.0025	0.0030	0.0015	0.002	0.0068	0.002	0.113165	0.002	0.00152	0.002	0.00057	0.001	0.00208	0.002	0.00057	0.00
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## IV. CONCLUSION

The ground water of Industrial area of west zone of central India samples were collected and analyzed for various physico-chemical parameters. The results of the above work i.e. temperature, TDS, nitrate, sulphate and Phosphate are well within the permissible limit except some samples of pH, turbidity, total hardness, DO, BOD and COD in study area during study periods mostly exceeded the value of WHO. From obtained result it is suggested to monitor the ground water quality and assess periodically to prevent the further contamination.

## V. ACKNOWLEDGEMENT

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