# ENVIRONMENTAL IMPACT ASSESSMENT: A COMPARATIVE STUDY TO EVALUATE AND VALIDATE THE EIA WITH SPECIAL REFERENCE TO AN INDUSTRIAL TOWN OF UTTARAKHAND (KASHIPUR)

**By**

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**DEPARTMENT OF CIVIL AND ENVIRONMENTAL SCIENCE**

**SUBMITTED TO**

*Harnessing Energy through Knowledge*

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TO

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DEHRADUN

MARCH, 2013

## DECLARATION

"I hear-by declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another per nor material which has been accepted for award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgement has been made in the text.

**Rajeev Kumar Sharma**
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Date:

## THESIS COMPLETION CERTIFICATE

This is to certify that the thesis on **"Environmental Impact Assessment: A Comparative Study to Evaluate and Validate the EIA With Special Reference to an Industrial Town of Uttarakhand (Kashipur)"** by **Rajeev Kumar Sharma** in partial completion of the requirements for the award of the degree of Doctor of Philosophy is an original work carried out by him under our joint supervision and guidance.

It is certified that the work has not been submitted anywhere else for the award of any other diploma or degree of this or any other University.

| | |
|---|---|
| Internal Guide | External Guide |
| **Dr. Nihal Anwar Siddique** | **Dr. Ashutosh Gautam** |
| Date: | Date: |

## ACKNOWLADGEMENT

I take this opportunity to express my sincere salutation to Almighty who gave me strength and blessings at each stage of study for Doctor of Philosophy. I pay thanks to my organization M/s India Glycols Limited for giving me consent to do the Doctor of Philosophy from University if Petroleum and Energy Studies, and also to UPES to register my candidature for Doctorate degree. I pay my regards and honor to my esteemed guide **Dr Nihal Anwar Siddiqui**, Associate Professor, Health, Safety, Fire and Environment Department, University of Petroleum and Energy Studies and **Dr. Ashutosh Gautam**, Joint General Manager (Environment and Quality Control), India Glycols Limited, Kashipur for there valuable suggestions, constructive criticism, inspiring guidance and sustaining my patience.

Management of M/s India Glycols Limited is highly thankful for giving me permission to use their laboratory for analytical work.

I would like to pay my sincere thanks to **Dr. S. J. Chopra**, Chancellor, **Dr. Parag Diwan**, Vice Chancellor of University of Petroleum and Energy Studies for giving me the opportunity to do Doctorate from esteemed University. I am also thankful to **Dr. Shrihari**, Dean College of Engineering Studies, UPES also for providing suggestion and guidance during synopsis and abstract presentation.

I also conveyed my gratitude to **Mr. M. K. Rao**, Executive Director, India Glycols Limited for their cooperation in facilitating the completion of this study.

Inspiration and wishes from my parents, wife cannot be traced on paper and they deserve more than a written acknowledgement. Motivation by my son and daughter has played a key role in completion of this work for which I shall remain indebted to them through out the life.

**Rajeev Kumar Sharma**

Date:

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# *Curriculum Vitae*

| | |
|---|---|
| ***Name:*** | ***Rajeev Kumar Sharma*** |
| ***Presently working at:*** | ***India Glycols Ltd.***<br>***Working as : General Manager (Health, Safety & Environment)*** |
| ***Earlier worked at:*** | ***Bhabha Atomic Research Center, Trombay (BARC)***<br>***Worked as : Scientific Officer-Station Officer*** |
| ***Experience:*** | ***27 years of Industrial experience*** |
| ***Areas heading:*** | ***Fire, Safety, Environment, Occupational Health, Quality Management Systems, Clean Development Mechanism , TPM/Lean Management, LCA studies and Industrial Engineering.*** |

***My career objective is to use my technical and analytical skills in the Challenging Environment to help the Organization as well as to the Society with the best of my background and to become a part of a team that dynamically work towards the growth of the organization and gain satisfaction.***

**I am with India Glycols Ltd. since 1988. Earlier to this job I was in Bhabha Atomic Research Centre, Trombay, Bombay as Station Officer. Presently I have around 27 years of experience in these related areas.**

**India Glycols Ltd. , where presently working, is a leading Green petrochemicals & specialty chemicals company manufacturing and marketing Ethylene Glycols, Glycol Ethers & its Acetates, Ethylene Oxide and its derivatives, Ethoxylates , Surfactants, Specialty Chemicals , Glycol Ethers & its Acetates, Industrial Gases, Liquor, Guar Gum etc. ; using state-of-the-art technologies from Scientific Design Inc.,USA; Sulzer Chemtech, Switzerland ; Pressindustria, Italy ; Sanyo Chemicals Industries, Japan ; Cadsen,USA and own R&D setup. India Glycols holds the distinction of being the only green petrochemical company of its kind.**

**Did my B.E. in Fire Engg., M.Sc. in Chemistry, Advanced Diploma in Industrial Safety and P.G.Diploma in Industrial Pollution Management . Presently I am also going to complete my Ph.D. from 'University of Petroleum and Energy Studies'.**

**Dy MR of IGL's Integrated Quality Management Systems (ISO 9001:2008, ISO 14001:2004, OHSAS 18001:2007, ISO 22000:2005, FSSC 22000:2010) and working for continual up gradation of the systems with inclusion of new certifications.**

**Lead Auditor of ISO 9001, ISO 14001 and qualified NRBPT Registered Environmental, Occupational Health & Safety (EHS) Legislation Internal Assessor. In addition to this I have qualified RC 14001 and RCMS Lead Auditor Training course.**

**Continual working for CDM (Clean Development Mechanism) feasibility for existing / proposed / on-going projects / activities. , for the reduction of GHG (Green House Gases) effects .**

**Working for Life Cycle Assessment (LCA) studies for the chemicals / products.**

**I have the privilege to be included in the list of distinguished professional of the World by the " MARQUIS WHO'S WHO,U.S.A., published in the 16th edition of "WHO;S WHO IN THE WORLD" Directory.**

**There is association with no. of National & International bodies as Member/Life Member/Fellow Member as with NSC-India, IIRSM-U.K ., IAEM-India, IIChE-India, NIE-India, ISIH-India, IISP-India, IChS-India, QCI, etc.**

***Life Member of :***

- Indian Association for Environmental Management (IAEM), at NEERI,
- Indian Institute of Chemical Engineers,
- National Institute of Ecology, School of Environmental Sciences, JNU,
- National Safety Council,
- Indian Society of Industrial Hygiene,
- Institution of Industrial Safety Professionals of India,
- Quality Council of India
- ASCI Alumni Association,
- Society for promotion of Occupational Safety, Health & Environment,
- Hindi Vigyan Sahitya Parishad, B.A.R.C.,
- Vigyan Parishad

***Fellow Member of:***

- Indian Chemical Society,

***Member of :***

- International Institute of Risk and Safety Management, U.K.
- The Institution of Fire Engineers (India)
- Consumer Education & Research Society

**Being a professional, I am also regularly associated / engaged in EHS Audits , EIA Studies, developing Emergency Plans and giving expert / specialized / technical advice to other industries / projects as a Team Leader / Lead Auditor / Motivator / as Secretary-National Safety Council State Chapter.**

**Member of 'State Crises Group' of Uttarakhand , as an expert.**

**Worked as Member of High Technical Committee for proposed Uttarakhand Fire & Emergency Services Development Project of Uttarakhand Govt.**

**A no. of technical papers are published / presented in various seminars / publications.**

- Poster cum Paper presented on "ACCIDENT CAUSATION" in XIII World Congress on Occupational Safety and Health at New Delhi

- Paper on "OCCUPATIONAL BURN ACCIDENTS IN INDUSTRIES", published in "The Fire Engineer" Vol.19,No.2

- Paper on "Accident CAUSATION", published in the "NFSC Journal" Vol.1,No.1

- Paper presented on "RURAL ECO-DEVELOPMENT-DEPENDENCY ON BASIC ENVIRONMENT CONDITIONS" in the ""IIIrd Annual Conference on Earth Day", organized by Institute of Rural Eco-Development, U.P.

- Paper on "SYSTEM APPROACH IN MANAGEMENT OF HAZARDOUS CHEMICALS", published in the special millennium issue- FIRETECH Journal of April-1999 issue of NFSC, Nagpur

- Paper on "ROAD TRANSPORTATION OF 'EO'- NON ACCEPTABLE RISK", in the "Workshop on the Transportation of Dangerous Goods" on 18/10/2001 at New Delhi, organized by FICCI and ICMA.

- Paper on "ETHYLENE OXIDE-SAFETY IN PRODUCTION AND DISTRIBUTION" in the seminar on " Surfactants: Recent Development and Applications" on 10-11'2007 at New Delhi, organized by Indian Institute of Chemical Engineers.

- Papers on "BUILDING SAFETY ATTITUDE", "HAZARD IDENTIFICATION & CONTROL", "WHAT IS SAFETY?" AND "BHOPAL DISASTER" in the program entitled "Building Safety Attitude" on 19th August'2008 at Bareilly, organized by Rohilkhand Management Association. Same program again done on 8th May,2010.

- Paper on "GENDER ISSUES IN OCCUPATIONAL SAFETY AND HEALTH PURVIEW" in the National Seminar on Safety, Health & Environment in Hazardous

Industries and related Gender Issues organized by Govt. of India, Min. of Labour & Employment , DGFASLI on 20th September'2008 at NOIDA.

- Papers on "ROLE OF CONSIGNOR. CONSIGNEE, TRANSPORTER AND DRIVER OF HAZMAT GOODS" and "A TRANSPORT ACCIDENT INVOLVING HAZARDOUS CHEMICALS- A CASE STUDY" in the 2 days National Workshop of the Ministry of Environment & Forest, Govt. of India on "Management of Chemical Accidents during Transportation" from 6-7 May,2010 at Dehradun.

- Papers on "BASIS AND BASICS OF INDUSTRIAL SAFETY" and "LEARNING FROM BHOPAL GAS TRAGEDY" in the one day Training Programme of National Safety Council of India – Western Action Centre: Ghaziabad, on "Industrial Safety" on 28 May,2010 at Bijnore, U.P.

- Paper on "ENVIRONMENTAL BENEFITS FROM BIO-MONO ETHYLENE GLYCOL PRODUCTION WITH THE APPLICATION OF LIFE CYCLE METHODOLOGY AND FOOT PRINTING TOOLS", in the 1st Indian Life Cycle Management & Life Cycle Assessment Conference, organized by FICCI with MoEF, UNEP, SETAC & LCI,at New Delhi on 22nd to 23rd August,2012.

- Paper on "STUDIES ON THE AMBIENT AIR QUALITY STATUS IN THE INDUSTRIAL BELT OF KASHIPUR, UTTARAKHAND. INDIA" published in Environment Conservation Journal (ISSN 0972-3099) Reference No.ECJ/3/12

- Paper on "STUDIES OF SURFACEWATER QUALITY OF THE KASHIPUR, UTTARAKHAND. INDIA" published in Environment Conservation Journal (ISSN 0972-3099) manuscript no. ECJ/546.

- Paper on "STUDIES OF GROUND WATER QUALITY ASSESSMENT AT INDUSTRIAL BELT OF KASHIPUR, UTTARAKHAND. INDIA" published in Environment Conservation Journal (ISSN 0972-3099)

**Various trainings/workshops/seminars are also attended in all relevant subjects / areas like Occupational Safety,Health & Environment; Pollution Abatement Techniques; On-Site / Off-Site Disaster Planning; HAZOP;QRA; HSE Workable Solutions; Environmental Mgt.; Environmental Emergencies; Hazardous Waste Mgt.; Plant Inspection Techniques and role of Inspection on Plant Performance & Safety; Fire Safety Mgt.; Industrial Safety & Health; Rupture Discs; TPM; Responsible Care; Industrial Insurance; Lead Auditor / Internal Auditor / Awareness courses in ISO 9001, ISO 14001, OHSAS 18001 , ISO 22000; World Class Manufacturing; World Class Human Resources in Quality, etc.**

**I am always in search of challenges and targeting them to resolve.**

# EXECUTIVE SUMMARY

The present study "Environmental Impact Assessment: A Comparative Study to Evaluate and Validate the EIA with Special Reference to an Industrial Town of Uttarakhand (Kashipur)" is carried out.

After formation of Uttarakhand as a new State rapid industrializations and urbanization took place and due to this there is great pressure on the environmental components. Hence, earlier environmental studies needs evaluation and validation with special reference to the EIA Notification 2006 and proposed Environmental Management Plan.

Kashipur is an old industrial town of Uttarakhand State, earlier belonging to Uttar Pradesh. This town experienced an industrialization way back in 1988 – 1989. Few major type of industries working in this area belongs to Distillery, Chemical, Paper and other small industries. After formation of Uttarakhand in the year 2000 and due to fiscal benefits various kinds of industries are coming up in this area, which includes paper, distillery, chemical and gas based thermal power plants etc.

**ENVIRONMENT IMPACT ASSESSMENT**

Environmental impact assessment (EIA) is the process of doing **predictive studies on a proposed development,** and analyzing and evaluating the results of this development, thus scientifically based EIA's are composed of two distinct parts;

(a) a predictive phase, which is meant to predict the effect of expected impacts before development occurs, and

(b) a monitoring and assessment phase, which is meant to measure and interpret environmental effects during construction and after the development has been completed.

Environmental clearance on the basis of Environmental Impact Assessment is mandatory for various developments projects in most part of the world today. In

India, this was introduced as an administrative measures in 1978-79, initially for river valley projects and extending late to industrial projects. There are about 29 categories of projects for which Environmental Clearance, was made mandatory by the environmental impact assessment (EIA) as per notification issued in January 1994 under the Environment Protection Act 1986(4). Certain activities permissible under the coastal regulation zone Notification 1991 also require clearance.

**AIR ENVIRONMENT**

Ambient Air quality monitored by the setting of Ambient Air quality monitoring stations with due consideration to the meteorological conditions of the regions as per the CPCB methods of Air quality parameters. In order to establish the baseline air quality status in a study area, about 10 ambient air quality stations were selected within the 10 Kms radius study area of the near industrial area including one station in downward direction as per the earlier EIA.

This study reveals that ambient air quality of study area is presently within limit of NAAQS.

**NOISE ENVIRONMENT**

Noise has a significant impact on the quality of life. The assessment of impacts of noise sources depend on the characteristics of noise. Noise level monitored of different location and compared with the CPCB Standards of noise.

Noise level is found higher near study area N-9 (Kashipur city) and N-10 (Gangapur Gosain) and vehicular movement is important source of noise at both places. Noise level of monitoring station is found within limit.

The study area near N-1 experience a marginal increase in ambient noise level due to the construction activity, the traffic for loading, unloading, fabrication and handling of equipment. The marginal increase of Noise level is reversible and localized in nature and mainly confined to the day hours and still found within limit. Noise level is found within limit during monitoring at monitoring station.

## WATER ENVIRONMENT

Water utilized by Industrial, Agricultural and domestic purpose in the study area. Hence to assess the physiochemical quality, water samples collected and analyzed as per the approved methods.

Water samples are collected from 10 locations for **Ground Water**. These water samples are analyzed in laboratory as per the methods described In IS: (3025-1964).

Sampling points were selected within the 10 Kms radius of study area of the proposed project site. These samples were selected on the basis of even distribution over the study area taking in to consideration various factors like topography of the region, proximity of sensitive establishment and human settlements, industrial activities in the area and its proximity etc.

A-1 Industrial area is located around 7 km east of Kashipur city. Uniqueness of this sampling point is the fact that all other samples are collected within 10 km radius of this sampling point. Ginni Khera is a very small village located around 3 km of Prolific Papers (P) Limited. Nandrampur is a village located near A-1 industrial area Kashipur. Dhakia Kalan is a village located around 7 km north east of A-1 industrial area. Dabhaura Mustahkam is a village located around ~2.5 of Chima Paper and ~2 km east of Multiwall Paper respectively. Barkheri is a village located around 2 km west of Chima Papers and around 2 km South of A-1 industrial area. Kharakpur Devipura is a village located in between A-1 Industrial area and Kashipur City. Kashipur sampling point represent the pollution load of domestic sewage penetrate to ground water. Gangapur gosain is located in approximately 6 km north of A-1 Industrial area. The sampling point is considered to be agriculture land and exhibit agri-business.

The various parameters determined were pH, color, EC (electrical conductivity), total dissolved solids (TDS), total hardness (TH), calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), carbonate ($CO_3^{2-}$), bicarbonate ($HCO^{3-}$), chloride ($Cl^-$), sulfate ($SO_4^{2-}$), Sodium

($Na^+$), potassium ($K^+$), Nitrate ($NO_3^-$), BOD(3 days at 27 degC), COD & Total coliform.

The result revealed that there was significant variation in some physicochemical parameters and most of the parameters were in the normal range and indicates better quality of ground water. It has been found that the water is best for drinking purpose in all the areas. In general all the parameters are within the range of standard values prescribed by various agencies.

**Water** samples were collected from six locations for **Surface Water** monitoring. Sampling location is set up to monitor the surface water quality in the study area. Each such sampling point represents a unique category of microenvironment.

The area under study is the basin of river Kosi which pass through Kashipur, Uttarakhand. The area under study is the basin of river Bahella which pass through Kashipur, Uttarakhand. The area under study is the Mahadev stream which passes through villages near Kashipur, Uttarakhand. The area under study is Khokratal which is near Kharagpur Devipura village of Kashipur, Uttarakhand.

Water samples collected from Kosi River, Mahadev stream, Bahela river are in all physico-chemical parameters examined. In general all the parameters are within the range of standard values prescribed by various agencies.

The water of Khokratal is found highly contaminated during the course of study and it is unfit for consumption, domestic and irrigation purposes.

**LAND ENVIRONMENT**

Field surveys were conducted to delineate classification of land use pattern around the study area. A number of villages situated in different directions and distances were selected for detailed characterization of land environment. Representative surface soil samples (15.0 & 30.0 cm depth) were collected for determination of soil characteristics that are significant to the nature of the project. Standard procedures were followed for soil sampling and analysis.

Assessment of **Soil** quality is an important aspect with reference to tree plantations, percolation of water, groundwater impact, etc. The soil quality of the study area is assessed by collecting samples at different locations.

Sampling points were selected within the 10 Kms radius of study area of the proposed project site. These samples were selected on the basis of even distribution over the study area taking in to consideration various factors like topography of the region, proximity of sensitive establishment and human settlements, industrial activities in the area and its proximity etc. The physical and chemical characteristics of the soil of the study area are assessed by analyzing various parameters.

The pH of soil samples was found to be more towards basic during monitoring. Conductance value and Chlorides are low. The concentrations of Sodium and Potassium in soil samples represent the use of chemical fertilizers in the surrounding agrifields.

**Environmental Impact Assessment** Studies for various components such as Air, Water (Ground and Surface), Soil, Meteorology, Demographic studies, etc are as per the plan adopted in earlier EIA Studies. Sampling locations and site characteristics are taken in to consideration as per earlier EIA as well as few new stations have been included to enhance the study further.

The construction and operational phase of the proposed project comprises various activities each of which may have an impact on environmental parameters. Various impacts during the construction and operation phase on the environment have been studied to estimate the impact on the environmental attributes and are discussed in the subsequent section.

**ENVIRONMENTAL IMPACT DURING CONSTRUCTION STAGE (Distillery, Pulp & Paper mill & Sugar mill):**

Impact on Topography and Land-use during the construction activities is envisaged to be insignificant due to following reasons:

- All the labor or contractor allowed to working in day hours normally.

- There was no any possibility of temporary change at large in land use pattern during construction period. However, land requirement for the projects optimized and allowed to set up in the designated place only.

Impacts on **Soil Environment were** envisaged to be minor because of the following reasons:

- It confined to the construction areas.
- Removed topsoil utilized for landscaping and land improvement in other areas, which are not under construction.

The **impact on Air Environment** of such activities were temporary and restricted to the construction phase only. Proper upkeep and maintenance of vehicles, sprinkling of water on roads at construction site, providing sufficient vegetation etc. were some of the proposed measures that greatly reduced the impact on the air quality during the construction phase of the projects. The impact of such activities were temporary and restricted to the construction phase only and confined within the project site in industrial area.

The **impact on Noise Environment** of such activities was likely to experience a marginal increase in Ambient Noise Level due to the constructional activity, the traffic for loading and unloading, fabrication and handling of equipment and materials, construction equipment like dozer, scrapers, concrete mixer, crane, generators pumps, and compressor, Pneumatic tools, vibrators, etc. Overall, the impact of generated noise on the environment during construction period was likely to be insignificant, reversible and localized in nature and mainly confined to the day hours normally. The noise level was dropped down to the acceptable level, once construction period was over.

The **Water** requirement for the project activity is sourced from existing bore well / water sources. The local labor force were deployed during construction phase and no colony is proposed as the workers will be employed from the nearby local villages. Minor impact was envisaged on ground water source during construction phase,

which was temporary. There is no surface water body in construction site. The sewage water generated during construction was disposed adjacently. Hence the effect on the water body was minimal.

Traffic volume on nearby roads was taken place due to movement of heavy vehicles as well as HEMMs during the construction phase, which causes public inconvenience. This had minimal affect considering the size of industrial Projects.

**ENVIRONMENTAL MANAGEMENT DURING CONSTRUCTION (Distillery, Pulp & Paper mill & Sugar mill):**

During excavation and transportation on roads at, there was a scope for local fugitive dust emissions. Frequent water sprinkling in the vicinity of the construction activity was done.

There is a likelihood of fugitive dust from the construction activity and material handling from the truck/vehicle movement in the area. The industry will take up tree plantation program around the plant site.

It will be ensured those construction vehicles are properly maintained. The vehicle maintenance area will be located in such a manner, so as to prevent contamination of water sources by accidental spillage of oil.

Location will be identified for the storage of such flammable and hazardous liquids, away from the main plant. The storage will be as per industrial safety standards.

The construction workers will be provided with sufficient and suitable toilet facilities to allow proper standards of hygiene.

Onsite workers using high noise equipment will adopt noise protection devices. Noise prone activities will be restricted to daytime hours only.

After completion of construction activities, the rubbish will be cleared and disposed to nearby authorized sites.

**ENVIRONMENTAL IMPACT DURING OPERATION STAGE (Distillery, Pulp & Paper mill & Sugar mill):**

**Assessment of Ambient Air Quality** is of paramount importance to understand the background of air quality before starting any new activity. In order to establish the baseline air quality status in a study area, about 10 ambient air quality stations were selected within the 10 Kms radius of study area of the near in A-1 industrial area including one station in downward direction as per the earlier EIA. These stations were selected on the basis of even distribution over the study area taking in to consideration various factors like topography of the region, proximity of sensitive establishment and human settlements, industrial activities in the area and its proximity, down wind direction etc. The primary sources of suspended particulate matter in the ambient air environment of industrial area of Kashipur are process of chemical plant, process of paper industries, from transportation of heavy vehicles and boilers in industries. A monitoring station (base station) is located at A-1 Industrial area (in industrial area) which is around 7 km east of Kashipur city. Uniqueness of this station is the fact that we are taking it as base station and all other station are within 10 km radius of this station.

This study reveals that ambient air quality of Kashipur industrial area is presently within limit of NAAQS. As per statically analysis ambient air quality of Kashipur city, we have concluded that air quality status is deteriorating as level of SO2 & SPM in on increasing path.

The **Ambient Noise** levels equivalent for 1-hour duration at 10 different locations will be recorded, keeping in view with the traffic movement and other noise generating activities in the region.

L MAX, L MIN, L eq, L10, L50 and L90, are monitored in the study area.

Noise level is found higher near study area N-9 (Kashipur city) and N-10 (Gangapur Gosain) and vehicular movement is important source of noise at both places. Noise level of monitoring station is found within limit.

The study area near N-1 (IGL) experiences a marginal increase in ambient noise level due to traffic from loading, unloading raw material and product. The marginal

increase of Noise level is localized in nature and mainly confined to the day hours and found within limit. Noise level is found within limit during monitoring at monitoring station.

**Water** is a vital essential commodity necessary for the survival of vegetation, animals and human beings and for proper balance of eco system itself. Hence it is necessary to study the quality of water in the study area to find out if industrial activities in and around the area have caused any deterioration in the environmental quality with respect to **Surface** and **Ground Water** sources, so that the health and growth of humans, flora, fauna and soil conditions are not affected adversely.

Water samples are collected from 10 locations for **Ground Water**. These water samples are analyzed in laboratory as per the methods described In **IS: (3025-1964)**.

Sampling points were selected within the 10 Kms radius of study area of the proposed project site. These samples were selected on the basis of even distribution over the study area taking in to consideration various factors like topography of the region, proximity of sensitive establishment and human settlements, industrial activities in the area and its proximity etc.

As per statically analysis Ground Water quality of Kashipur city, we have concluded that Ground Water quality status is in deteriorating as level of Total Hardness; Sulfate as $SO_4$ etc. are on increasing path. Although it will be within limit of WHO drinking water standard even after extrapolating the same up to 2020.

The various parameters determined were pH, color, EC (electrical conductivity), total dissolved solids (TDS), total hardness (TH), calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), carbonate ($CO_3^{2-}$), bicarbonate ($HCO^{3-}$), chloride ($Cl^-$), sulfate ($SO_4^{2-}$), Sodium ($Na^+$), potassium ($K^+$), Nitrate ($NO_3^-$), BOD(3 days at 27 degC), COD & Total coliform.

The result revealed that there was significant variation in some physicochemical parameters and most of the parameters were in the normal range and indicates better quality of ground water. It has been found that the water is best for drinking purpose

in all the areas. In general all the parameters are within the range of standard values prescribed by various agencies.

**Water** samples are collected from six locations for **Surface Water** monitoring. Sampling location are set up to monitor the surface water quality in the study area. Each such sampling point represents a unique category of microenvironment.

The area under study is the basin of river Kosi which pass through Kashipur, Uttarakhand. The area under study is the basin of river Bahella which pass through Kashipur, Uttarakhand. The area under study is the Mahadev stream which passes through villages near Kashipur, Uttarakhand. The area under study is Khokratal which is near Kharagpur Devipura village of Kashipur, Uttarakhand.

Water samples collected from Kosi river, Mahadev stream, Bahela river is in all physico-chemical parameters examined. In general all the parameters are within the range of standard values prescribed by various agencies.

As per statically analysis Surface Water quality of Kosi River SW-4 in the study area, we have concluded that Water quality parameter are within the limit different water standard even after extrapolating the same up to 2020.

The water of Khokratal is found highly contaminated during the course of study and it is unfit for consumption, domestic and irrigation purposes.

Assessment of **Soil** quality is an important aspect with reference to tree plantations, percolation of water, groundwater impact, etc. The soil quality of the study area is assessed by collecting samples at different locations.

Sampling points were selected within the 10 Kms radius of A-1 Industrial area as study area. These samples were selected on the basis of even distribution over the study area taking in to consideration various factors like topography of the region, proximity of sensitive establishment and human settlements, industrial activities in the area and its proximity etc. The physical and chemical characteristics of the soil of the study area are assessed by analyzing various parameters.

The pH of soil samples was found to be more towards basic during monitoring. Conductance value and Chlorides are low. The concentrations of sodium and potassium in soil samples represent the use of chemical fertilizers in the surrounding agrifields.

**ENVIRONMENTAL MANAGEMENT DURING OPERATION STAGE (DISTILLERY)**

**After assessment of Ambient Air Quality** in a study area, with about 10 ambient air quality stations within the 10 Kms radius study area of the proposed project site including one station in downward direction as per the earlier EIA. This study reveals that ambient air quality of Kashipur industrial area is presently within limit of NAAQS. As per statistically analysis ambient air quality of Kashipur city, we have concluded that air quality status is deteriorating as level of SO2 & SPM in on increasing path.

Since steam requirement for the proposed installation will met from fossil fuel boiler, hence, additional load of $SO_2$, NOx, hydrocarbons, flue gases etc on air environment would expected. So air pollution is envisaged from the proposed unit.

Minor emission of particulate matter will be expected to generate from handling & processing of raw material, which will be controlled by sprinkling of water on affected area. Further, green belt of the existing complex will be strengthened to reduce the effect of minor pollutants. PM controlled at source by providing specifically designed ESP, Bag filter etc. at boiler stack. Proper designing of air fuel mixture in boiler and heater will help to reduce NOx reduction.

In the **Convention approach of distillery effluent treatment**, the Effluent Treatment plant design is for the Ultimate Capacity of distillery. The ETP was constructed in two stages (i.e. primary treatment for first stage and secondary treatment for second stage).

Spent wash shall be treated based on Anaerobic Digestion principles for Primary Treatment and Aerobic Treatment as Secondary Treatment. After Secondary

Treatment the treated wastewater is subjected to Reverse Osmosis & Multi-Effect Evaporation Process. Final sludge is being treated through bio-composting process. The overall objective is to achieve "***Zero Discharge"***. The Guidelines of CPCB for the design of Bio-methanation Plant, "Composting Process" is being followed.

In the **Modified Approach of distillery effluent disposal** is by "effluent concentration followed by combustion"

Effluent is received in a level controlled balance tank and passed through pre-heaters, calandrias and vapor separators of various effects. The evaporation takes place under vacuum, which is maintained mainly by vacuum system. Steam is supplied as a heating medium to high heater and through thermal vapor recompression (TVR) to the first effect jacket. The concentrated product (SLOP) at the desired concentration is continuously taken out from the plant. The Slop (concentrated spent wash) from the evaporator and other biomass is used as fuel in specially designed boiler for the generation of steam followed by electricity.

**ENVIRONMENTAL MANAGEMENT DURING OPERATION STAGE (PULP AND PAPER INDUSTRY)**

**After assessment of Ambient Air Quality** in a study area, with about 10 ambient air quality stations within the 10 Kms radius study area of the proposed project site including one station in downward direction as per the earlier EIA. This study reveals that ambient air quality of Kashipur industrial area is presently within limit of NAAQS.

Since steam requirement for the proposed installation will met from fossil fuel boiler, hence, additional load of $SO_2$, NOx, hydrocarbons, flue gases etc. on air environment would expected. So air pollution is envisaged from the proposed unit.

Minor emission of particulate matter will be expected to generate from handling & processing of raw material, which will be controlled by sprinkling of water on affected area. Further, green belt of the existing complex will be strengthened to reduce the effect of minor pollutants. PM will controlled at source by providing

specifically designed ESP, Bag filter etc. at boiler stack. Proper designing of air fuel mixture in boiler and heater will help to reduce NOx reduction.

In the **Conventional Approach of Pulp & Paper mill Effluent Treatment** the sludge digesters can be eliminated by following reasons.

1. Primary sludge consisting mostly of cellulosic fiber does not require digestion and can be disposed after dewatering and drying.
2. The volume of the excess secondary sludge is comparatively lower than the primary sludge and this sludge can be returned to the primary setting tank.

It is also possible to establish simply open lagoon as primary and secondary sludge treatment if sufficient land area is available.

The degree of treatment required will depend upon the final mode of disposal, whether on land for irrigation or into sewer, municipal sewer or into inland surface water.

There are alternative treatment methods for **Small Paper Mills.** The **alternative I** treatment method is although similar to **alternative II**, differs from it in two ways. In this **alternative I**, it segregates about 50% of black liquor from straw and 20% from rag digesters. The segregated black liquor (4.5 m2 per ton of paper) is proposed to be stored in a lagoon and discharged into river during monsoon. Other waste water (about 200 m3/ton of paper) after primary clarification are treated in an aerated lagoon instead of activated sludge. Nutrient addition is needed in this case in the same proportion. The aerated lagoon will be provided with a silting chamber to prevent escape of solids in the effluent. Normally no excess sludge is expected from aerated lagoon. Primary sludge will be disposed of into the sludge lagoons. Effluent of aerated lagoon is expected to have a BOD of 30 mg/l and suspended solids of 80 mg/l and is fit for discharge into inland surface waters except for COD and color.

In this **Alternative II**, it is proposed to use the combined waste, resulting after segregation of black liquor as suggested in alternatives I, on land for agricultural utilization.

The combined waste water will be taken through a clarifier to remove the settleable solids. The clarified waste water after mixing with calcium sulphate, (Gypsum), to bring down the percent sodium below 60, will be used on land for irrigation. Depending on the type of soil, crop grown and the climate conditions, a certain dose of waste can be applied on land.

It is of importance to mention that the studies carried out by NEERI, on agricultural utilization of pulp mill wastes, have indicated that several Kharif and Rabi crops (except 3 varieties of grass and groundnut) have responded favorably when irrigated with pulp mill effluent as such or diluted with plain water.

Continued use of the wastewater on land is likely to create ground water pollution due to percolation of the adsorbed color. This is drawback for this method of disposal.

In the **Modified Approach of Discharge Scheme For Pulp And Paper** Industry the Effluent is treated by segregating effluent from generation end.

**Technological change** in Pulp & Paper mill by switch over to the elemental chlorine (Cl2) free bleaching (ECF) technology using chlorine dioxide bleaching looking into its advantages in significant reduction in formation of dioxins, furans and AOX related compounds along with improved brightness attainment.

In ECF bleaching technologies one of the main requirement for induction of chlorine dioxide stage is the complete changeover from MS to special grades of alloyed stainless steel (SS) system to prevent corrosion. This calls for heavy investments and scrapping the entire system in bleaching section for chlorine dioxide. In recent times the large mills have started partial replacement of chlorine by chlorine dioxide. A few mills have switched over to ECF bleaching. The adoption of these new technologies involves huge capital investment.

Recently Ozone has attracted the attention of the paper industry as one of the most effective bleaching agents and some of the mills have adopted the total chlorine free bleaching (TCF) techniques using ozone, oxygen and hydrogen peroxide. The

adoption of TCF bleaching has led to the concept of system closure as no toxic chlorinated compounds and recalcitrant are present in TCF effluent.

**ENVIRONMENTAL MANAGEMENT DURING OPERATION STAGE (SUGAR INDUSTRIES)**

**After assessment of Ambient Air Quality** in the study area, with about 10 ambient air quality stations located within the 10 Kms radius of industrial area including one station in downward direction as per the earlier EIA. This study reveals that ambient air quality of Kashipur industrial area is presently within limit of NAAQS.

Steam requirement for the sugar plant is met from boiler where bagasse is used as fuel in the boiler in all the sugar mill thus no additional load of CO2, $SO_2$, NOx, hydrocarbons, flue gases etc on air environment would expected. Thus negligible air pollution is envisaged from the industry.

Minor emission of particulate matter will be expected to generate from handling & processing of raw material, which will be controlled by sprinkling of water on affected area. Further, green belt of the existing complex will be strengthened to reduce the effect of minor pollutants. PM will controlled at source by providing specifically designed ESP, Bag filter etc. at boiler stack. Proper designing of air fuel mixture in boiler and heater will help to reduce NOx reduction.

In the **earlier days sugar mill wastewater** was reported to be discharged into a swamp measuring approx. 25 to 30 hectare area (**Conventional Method**). A maximum 8days retention time was reported to be sufficient for complete mineralization of organic carbon with a carbon loading of 60 to 170 mg/liters organic carbon.

In the **Modified approach** of effluent discharge from sugar mill is treated by aerobic and/or anaerobic process. In the aerobic processes large area is required to setup aerated lagoons, activated sludge process etc although it is also a conventional approach of Sugar mill effluent treatment.

Anaerobic biological processes (oxidation ponds and bio-methanation) have several advantages over aerobic processes (aerated lagoons, activated sludge process). Anaerobic processes are easier to control and operate, produce a lower quantity of sludge and their costs are lower. Anaerobic processes decompose the organic compounds in an atmosphere free of oxygen and consequently require significantly less energy as compared to aerobic processes.

UASB (Up Flow Anaerobic Sludge Blanket) design is feasible to treat sugar industry wastewater efficiently with a COD removal efficiency of 89% at much lower HRT of 6 h. Methane rich (more than 75%) biogas can be produced at the rate of 4.66 L/L. d. These methane rich biogas is used in boiler for thermal energy generation.

The final treated Effluent is utilized through aerobic bio-composting process with press mud and irrigation of the surrounding agricultural land.

It is a development that meets the needs of today's generation without compromising those of future generations. In view of this concept there is need of the time that EIA comparative studies should be conducted at periodic intervals to monitor the environmental impacts due to continual progressing with advanced technologies and growth of industrial sectors along with all socio-economic changes with Sustainable development.

With the available present scenario and industrial growth rate, the environmental indicators / parameters are also predicted up to 10 years period. This study concludes with understanding of the impacts and changes with available technologies for pollution abatements in an industrial area of Kashipur. From this study we may perceive that the present environmental status w.r.t. the various indicators are within prescribed limits.

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# 1 INTRODUCTION

Environmental Impact Assessment (EIA) is a formal process used to predict how industrial development or construction project will affect natural resources such as Water, Air, Land, Socio-economic and Wildlife.

Environmental Impact Assessment studies have mostly been applied to individual projects and have led to various Offshoot Techniques, such as Health Impact Assessments, Social Impact Assessments, cumulative effects assessments, and strategic environmental assessments (Environmental Assessments of Proposed Policies, Programs, and Plans). In some Cases, Social and Economic Impacts are assessed as part of the Environmental Impact Statements. In other cases, they are considered separately.

The term environmental impact assessment or variation of it, has come to have a variety of meanings over the last several years (Rosenberg and others, 1981, Beanlands and Duinker 1983, Hirst 1984, Larkin 1984). Here we adopt the following, simple definition:

Environmental impact assessment (EIA) is the process of doing predictive studies on a proposed development, and analyzing and evaluating the results of this development (Lash and others, 1974), thus scientifically based E.I.A's are composed of two distinct parts; (a) a predictive phase, which is meant to predict the effect of expected impacts before development occurs, and (b) a monitoring and assessment phase, which is meant to measure and interpret environmental effects during construction and after the development has been completed (Rosenberg and Others, 1981). Numerous publication are available that deal with E.I.A. methods (Rosenberg and others 1981, Beanlands and Duinker 1983, Rosenberg et al. 1986).

Environmental Impact Assessment (EIA) of a project attempts to bring about compatibility between ecology and econometrics (Luhar and Khanna 1988). EIA was introduced in the USA by formulation of National Environmental Policy (NEPA) in 1989.

The purpose of this act was "to declare a national policy which will encourage productive and enjoyable harmony between man and environment, to promote efforts which will prevent or eliminate damage of the environment and biosphere and understanding of

ecological systems and natural resources important to the nation, to establish a council of environmental quality (Rathore, 1988).

Environmental clearance on the basis of Environmental Impact Assessment is mandatory for various developments projects in most part of the world today. In India, this was introduced as an administrative measures in 1978-79, initially for river valley projects and extending late to industrial projects. There are about 29 categories of projects for which Environmental Clearance, was made mandatory by the environmental impact assessment (EIA). Notification issued in January 1994 under the Environment Protection Act 1986. Certain activities permissible under the coastal regulation zone Notification 1991 also require clearance.

In 1985, the Government had published a set of guidelines, recommended by a working group, for sitting up various developments projects including industries, power plants and mining. In addition, Government offices notifies, from time to time, certain areas in the country as ecologically sensitive and developmental activities to be taken up in these areas are regulated through the provisions of these notifications. Such areas include coastal regulated zone (CRZ), DOON valley, Murud-Janjira, Dahanu Taluka, Numaligarh, Taj Trapezium and Aravali ranges in Gurgaon (Haryana) and Alwar (Rajasthan) districts. Activities to be taken up in forest areas are governed by Forest (conservation) Act and Wild Life Protection Act, 1972. An amendment to the EIA Notification introduced in April 1997 has made public hearing mandatory for all the cases, where the environmental clearance is required.

The purpose of Environmental Impact Assessment is to identify and evaluate the potential impacts (beneficial and adverse) of development projects on environmental components including social, cultural, and aesthetic concerns. The exercise should be taken well in advance in planning stage of projects for selection of environmentally compatible sites, process technologies and such other environmental safeguards. The potential scope of a comprehensive EIA system is considerable and could include the appraisal of policies, plans, programs, and specific projects. The aim of the EIA is to assess the overall impact on the environment of development projects proposed by the public and private sectors.

Environmental Impact Assessment (EIA) in its simplest terms is the assessment before any decision is taken of the future impact of the consequence of that decision for the quality of the total human environment on which man largely depends for his well being.

EIA is future oriented in that it sets out to know what are the long term effects in on place, what are the consequences of impacts away from the initial site what are the induced effects, through the food chains, through modification of natural habitats, through disturbance of natural, physical and ecological equilibrium and even we can say the induced impact on man of these changes in his environment.

According to National Environmental Policy Act (NEPA) 1969 "Environmental Impact is any alteration of Environmental conditions or creation of a new set of environmental conditions adverse or beneficial caused or induced by the action or set of actions under consideration.

The study of probable changes in the socio and biophysical characteristics of the environment which may result from a proposed or impending action had been incorporated later (Jain et al , 1977).

There are a set of procedures which pursuit a understanding of the likely consequences of new economics growth activities of the environment (Fisher 1974). Munn (1975) defines EIA as an activity designed to identify and predict the impact on man's health and well being of legislative proposals, policies, programs, projects and operational procedures and interpret and communicate information about the impacts. EIA is also known as "The administrative process by which the Environmental Impacts of a project is determined (Fuggle 1979). Beanlands and Duniker (1983) defined EIA as "a process or set of activities designed to contribute pertinent environmental information to project decision making.

Generally impacts can be categorized as either primary or secondary. One way to describe the distinction is that projects inputs generally cause primary impacts and project output generally cause secondary impacts. Primary impacts are easier to analyze and measure while secondary impacts are usually more difficult to measure.

In other words "Primary impacts" are those that can be attributed directly to the proposed action. "Secondary Impacts" on the other hand are indirect or induced changes, and include the associated investments and changed patterns of social and economic activities likely to be stimulated or induced by the proposed action.

Various EIA steps have been proposed following essential steps required for EIA (Rathore 1988 & Fischer et al 1973).

(i) Identification of the planned and induced economic activities.
(ii) Identification of the affected environmental elements.
(iii) Evaluation of the initial and adverse environmental impacts generated by the planned and induced activities over time.

Jain, Urban and Stacey (1977) identified four basic steps for every EIA.

1. A complete understanding of proposed action.
2. A complete understanding of environment likely to be affected.
3. Projection of the proposed action into the future and thus determining the possible impacts on the environmental characteristics.
4. Presentation of the result in a manner that the analysis of the probable environmental consequences can be incorporated or used in a decision making process.

Rosenberg and Resh et al (1981) have proposed that an ideal EIA should have following elements.

1. Definition of scientific objectives
2. Back ground preparations
3. Identification of main impacts
4. Prediction of effects
5. Formulation of usable recommendations
6. Monitoring and assessment
7. Sufficient lead time
8. Public participation
9. Adequate funding
10. Evidence that recommendations were used.

Nichals and Hyman (1982) gave significant attributes of an "ideal EIA" in there area:

1. Inclusion of probabilistic nature of effects by EIA system
2. Segregation of short term and long term effects so as to reflect dynamic environmental effects.
3. Cumulative and indirect effects must be included.
4. Segregation of facts and values.
5. Efficiency on requirement of time, money and skilled labor.
6. Inclusion of diverse nature of environmental quality.
7. Facilities of expert and public participations.

A number of reviews are now available on EIA philosophy & theory. Efford (1975) had enumerated problems associated with environmental impact studies in Canada. He had referred that though EIA is increasing in number is Canada and are slowly improving but great efforts are needed to make them more useful to the people, they are designed to serve.

Richard (1980) discussed environmental impact assessment in terms of theory and in practices. His experience has shown that if the theory is applied too rigorously, the object of the exercise is defeated and EIA become a hindrance rather than a useful planning tool. He discussed the need for flexible guidelines rather than rigorous standards and criteria.

Buffington, Sharma and McFodden (1980) presented an summary of discussion at the workshop on biological significance of environmental impacts held at Michigan. Reviewed topics on data gathering, hypothesis, testing impact on species lists, methodology, modeling and elements of impact significant.

Qnono (1985) highlight the situation when EIA is needed, in his paper presented at the IV CAFEO conference in Manila, Philippines. Sept. 25-27, 1985. His paper reviewed the organizational, institutional and financial requirements of an EIA study for developing countries.

Rathore (1988) has presented “an ecosystem approach based model for EIA. This work endeavors to fill the gap in terms of an overall integrated ecological conceptual frame and a practical, objective package based on the logic evolved from ecosystem theory.

Because the EIA process is usually ended once development is complete, there are few examples of EIA's for which both predication and monitoring phases are available.

Unfortunately, the monitoring and assessment phase usually deleted (Rosenberg and other 1981, Larkiin 1984), although its importance's in evaluation the predictions made, cannot be over-estimated (Rosenberg and other, 1981, Bealands and Duinker 1983, Heeky and Others, 1984).

An EIA usually involves a sequence of steps:

I. Screening to decide if a project requires assessment and to what level of detail.

II. Preliminary assessment to identify key impacts, their magnitude, significance, and importance.

III. Scoping to ensure the EIA focuses on key issues and to determine, where more detailed information is needed.

IV. Implementing the main EIA study, which involves detailed investigations to predict impacts, assess their consequences, or both.

**THE EIA CYCLE AND PROCEDURES**

The EIA process in India is made up of the following phases:

- Screening
- Scoping and consideration of alternatives
- Baseline data collection
- Impact prediction
- Assessment of alternatives, delineation of mitigation measures and environmental impact statement
- Environment Management Plan
- Decision making

Monitoring the clearance conditions

**NEED FOR EIA**

Every anthropogenic activity has some impact on the environment. More often it is harmful to the environment than benign. However, mankind as it is developed today cannot live without taking up these activities for his food, security and other needs. Consequently, there is a need to harmonize developmental activities with the environmental concerns. Environmental impact assessment (EIA) is one of the tools available with the planners to achieve the above-mentioned goal.

It is desirable to ensure that the development options under consideration are sustainable. In doing so, environmental consequences must be characterized early in the project cycle and accounted for in the project design.

The objective of EIA is to foresee the potential environmental problems that would arise out of a proposed development and address them in the project's planning and design stage. The EIA process should then allow for the communication of this information to:

A. The Project Proponent;

B. The Regulatory Agencies; and,

C. All Stakeholders and Interest Groups.

EIA integrates the environmental concerns in the developmental activities right at the time of initiating for preparing the feasibility report. In doing so it can enable the integration of environmental concerns and mitigation measures in project development. EIA can often prevent future liabilities or expensive alterations in project design.

**INDIAN POLICIES REQUIRING EIA**

The Environmental Impact Assessment in India was started in the year 1976-77 when the Planning Commission asked the then Department of Science and Technology to examine the river-valley projects from environmental angle. This was subsequently extended to cover those projects, which required approval of the Public Investment Board. These were administrative decisions, and lacked the legislative support. The Government of India enacted the Environment (Protection) Act on 23rd May 1986. To achieve the objectives of the Act, one of the decisions that were taken is to make environment impact assessment statutory. After following the legal procedure, a notification was issued on 27th January 1994 and subsequently amended on 4$^{th}$ May 1994, 10th April 1997, 27th

January 2000 and 7th July 2004 making environment impact assessment statutory for 32 Projects /Activities. The new EIA notification was issued on 14th September 2006. This is the principal piece of legislation governing environment impact assessment.

In order to get an idea about the existing state of the environment, various environmental attributes such as meteorology, air quality, water quality, soil quality, noise level, ecology and socio-economic environment were studied /monitored. Detailed flora fauna were carried out in the study area comprising of core and buffer zone for identification of existing species and classifying them as per Wildlife (Protection) Act, 1972.

**APPLICABLE ENVIRONMENTAL REGULATIONS AND STANDARDS**

With respect to prevention and control of environmental pollution, the following Acts and Rules of Ministry of Environment and Forest, Government of India govern the proposed project:

- Water (Prevention and Control of Pollution) Act, 1974 as amended in 1978 and 1988.
- Air (Prevention and Control of Pollution) Act, 1981 as amended in 1987.
- Environment (Protection) Act, 1986 amended in 1991 and Environment (Protection) rules, 1986 and amendments thereafter.
- Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008.

**SCOPE OF ENVIRONMENT IMPACT ASSESSMENT (EIA)**

The study includes detailed characterization of existing status of environment in an area of 10.0 km radius around Proposed Plant for various identified environmental components viz. air, noise, water, land, biological and socio-economic. Under the scope of EIA, it is envisaged:

- To access the present status of air, noise, water, land, biological and socio-economic components of the environment.
- To identify, quantify and evaluate significant impacts of operations on various environmental components.

- To evaluate proposed pollution control measures and delineate environmental management plan (EMP) outlining additional control measures to be adopted for mitigation of adverse impacts.
- To delineate post-project environmental quality monitoring programme.

**PURPOSE OF THE EIA REPORT**

Environmental Impact Assessment is a tool that seeks to ensure sustainable development through evaluation of those impacts arising from the proposed activity that are likely to have significant environmental effects. In India, Environmental Impact Assessment study is a mandatory since 1994 under the Environment Protection Act and carried with the objectives:

- Predict environmental impacts of the project
- Find ways and means to reduce adverse impacts if any
- Shape the project to suit the local environment
- Impacts predictions and mitigative options to the decision – maker

The proposed project was selected and designated as Study Area for the purpose of Environmental Impact Assessment Study. Field data were collected and this period was designated as Study Period for the purpose of Environmental Impact Assessment of the said project.

**ORGANIZATION OF THE STUDY**

Reconnaissance survey was conducted and sampling locations were identified on the basis of,

a) Existing topography.
b) Locations of water intake and effluent collection/storage points from domestic/other sources.
c) Location of villages /towns/sensitive areas.
d) Accessibility of power availability and security of monitoring equipment.
e) Pollution pockets in the area.

f) Areas that represent baseline conditions.

**COMPONENTS OF EIA**

The difference between Comprehensive Environmental Impact Assessment and Rapid Environmental Impact Assessment (REIA) is in the time-scale of the data supplied. REIA is for speedier appraisal process. While both types of EIA require inclusion / coverage of all significant environmental impacts and their mitigation, REIA achieves this through the collection of 'one season' (other than monsoon) data only to reduce the time required. This is acceptable if it does not compromise on the quality of decision-making. The review of REIA submissions will show whether a comprehensive EIA is warranted or not. It is therefore clear that the submission of a professionally prepared Comprehensive EIA in the first instance would generally be the more efficient approach. Depending on nature, location and scale of the project EIA report should contain all or some of the following components.

- Air Environment
- Noise Environment
- Water Environment
- Biological Environment
- Land Environment
- Socio-Economic and Health Environment
- Risk Assessment
- Environment Management Plan

## 1.1 OBJECTIVES

To assess the Impact of Industrialization on the environment by comparing the present investigation with earlier EIA and proposed Environmental Management Plan carried out in the year 2000 with special reference to an Industrial town of Uttarakhand.

Objectives of the study are categorized in the following broader topics:

i)- Environmental Impact Assessment for the study period.

ii)- Comparison vis-à-vis evaluation with earlier EIA of the region.

iii)- Impact predictions to current as well as for next five year with the help of mathematical modeling.

iv)- Details of industrial effluent along with techno- economic evaluation of the available treatment technologies proposed.

v)- Environmental Management Plan (EMP) to describe the abatement technologies to combat air, water, soil and noise pollution.

## 1.2 OUTLINE OF THESIS

The thesis covers following chapters:

I. Literature survey contains information about the methodology used for EIA studies and its modification. It also consists of information about the study on Air Environment, Noise Level monitoring, Water Environment, and Soil Environment.

II. Metrological data consist of historical metrological study of study area as well as metrological data of study period.

III. Study of Air monitoring consists of AAQSM methodology, result & discussion of Ambient Air Quality Status Monitoring.

IV. This chapter consists of study of Noise level monitoring (methodology, result & discussion of Noise Level Monitoring of study area)

V. This chapter consists of study of Water Quality monitoring (methodology, result & discussion of Surface Water & Ground Water quality monitoring of study area)

VI. This chapter consists of study of Soil Quality monitoring (methodology, result & discussion of Soil quality monitoring of study area)

VII. This chapter consists of study of Demography Status of study area.

VIII. This chapter consist of Prediction of Environmental Impact during construction stage of projects (Distillery/Pulp & Paper mill / Sugar mill) and operation stage of projects(Distillery/Pulp & Paper mill / Sugar mill)

IX. This chapter consist of Environmental Management Plan to reduce Environmental Impact (predicted during impact assessment) during construction stage of projects (Distillery/Pulp & Paper mill / Sugar mill) and operation stage of projects(Distillery/Pulp & Paper mill / Sugar mill)

X. Result and Discussion with respect to Environmental Study, Environmental Impact Prediction & Environmental Management Plan is summarized and concluded in separate chapter.

XI. Reference and Appendix.

## 1.3 RESEARCH METHODOLOGY

Kashipur is an old industrial town of Uttarakhand State, earlier belonging to Uttar Pradesh. This town experienced an industrialization way back in 1988 – 1989. Growing awareness about the state of our environment has resulted in the increased attention towards environmental assessment and protection With this increased concern, Environmental Impact Assessment Studies need to be evaluated and validated for a particular set of environmental parameters and reference. To have it in practice this research is started. Therefore, this research is proposed to evaluate and validate the earlier EIA carried out at Kashipur of Uttarakhand.

### 1.3.1 Theoretical framework

Environmental Impact Assessment Studies for various components such as Air, Water (Ground and Surface), Soil, Meteorology, Demographic studies, etc. are as per the plan adopted in earlier EIA Study. Sampling locations and site characteristics are taken in to consideration as per earlier EIA as well as few new stations have been included to enhance the study further. Sampling locations are presented in the table below and on 10 Km Radius Map.

### 1.3.2 Source of Data

i) Primary data of various environmental aspects are collected as per following plan

**Table 2.1: Monitoring Stations for Data Collection in Study area**

| Parameter | Locations for proposed data collection | Source |
|---|---|---|

| Parameter | Locations for proposed data collection | Source |
|---|---|---|
| 1. Ambient Air Quality | 10 Locations | Primary |
| 2. Ground Water | 10 Locations | Primary |
| 3. Surface Water | 06 Locations | Primary |
| 4. Soil | 10 Locations | Primary & Secondary |
| 5. Noise Level | 10 Locations | Primary |
| 6. Ecology | Study Area | Primary & Secondary |
| 7. Geology & Hydrology | Study Area | Secondary |
| 8. Land Use | Study Area | Primary & Secondary |
| 9. Socio-Economic | Study Area | Secondary |

ii) Secondary data is collected from published sources and Government agencies

| | |
|---|---|
| Census data | Revenue Department |
| Land Use | GIS based Technology |

### 1.3.3 Sampling and Analysis

Sampling and analysis is carried out as per the defined analytical procedures. Sampling locations and site characteristics are as per earlier EIA . Sampling locations are also presented in the 10 Km Radius Map at respective places along with few new stations which are described at respective places in the following paragraphs.

An area of 10 Km radius has been selected for Environment Impact Assessment studies. The work carried out is briefly reported below and described in detail in subsequent sections.

**AIR ENVIRONMENT**

Ambient Air quality monitored by the setting of Ambient Air quality monitoring stations with due consideration to the meteorological conditions of the regions as per the CPCB methods of Air quality parameters.

**NOISE ENVIRONMENT**

Noise has a significant impact on the quality of life. The assessment of impacts of noise sources depend on the characteristics of noise. Noise level monitored of different location and compared with the CPCB Standards of noise.

**WATER ENVIRONMENT**

Water utilized by Industrial, Agricultural and domestic purpose in the study area. Hence to assess the physiochemical quality, water samples collected and analyzed as per the approved methods.

**LAND ENVIRONMENT**

Field surveys were conducted to delineate classification of land use pattern around the study area. A number of villages situated in different directions and distances were selected for detailed characterization of land environment. Representative surface soil samples (15.0 & 30.0 cm depth) were collected for determination of soil characteristics that are significant to the nature of the project. Standard procedures were followed for soil sampling and analysis.

**SOCIO -ECONOMIC ENVIRONMENT**

Data on the demographic pattern, population density, educational facilities, agriculture income, fuel, medical facilities, health status, transport and recreational facilities were collected from the study area and analyzed.

All the aforesaid environmental parameters have been used for identification, prediction and evaluation of significant impacts. An Environment Impact Statement (EIS) was prepared after identifying, predicting and evaluating the impacts. An environmental management plan has been delineated.

Kashipur is an old industrial town of Uttarakhand State, earlier belonging to Uttar Pradesh. This town experienced an industrialization way back in 1988 – 1989. Few major

type of industries working in this area belongs to Distillery, Chemical, Paper and other small industries. After formation of Uttarakhand in the year 2000 and due to fiscal benefits various kinds of industries are coming up in this area, which includes paper, distillery, chemical, and gas based thermal power.

**Industrial Activity in Kashipur Area**

| Industry | Location | Product |
|---|---|---|
| India Glycols Limited | Bazpur Road | Chemicals |
| Goraya Straw Board Mills Pvt Ltd | Bazpur Road | Paper |
| Multiwal Pulp & Board Mills (P) Ltd. | Bazpur Road | Paper |
| Prolific Papers (P) Limited | Village Girdhai, Aliganj Road, | Paper |
| Cheema Papers Ltd | Nainital Road | Paper |
| Shravanti Energy | Aliganj Road | Electricity (yet to start) |
| Gama Energy | Mahua Khera Ganj | Electricity (yet to start) |
| Beta Energy | Mahua Khera Ganj | Electricity (yet to start) |
| Naini Paper | Ramnagar Road | Paper |
| SRF | Ramnagar Road | Chemical |
| Kashi Vishwanth Steels Ltd | Bazpur Road | Steel, Special Alloys |
| Jindal Baverages | Bazpur Road | Frozen Foods, Edible Oils |
| Triveni Engineering & Industries Ltd. | Pipli | Sugar |
| Rana Sugar Ltd | Tanda- Bazpur Road | Sugar |
| The Kisan Sahkari Chini Mills Ltd. | Gadarpur & Sitarganj | Sugar |

# 2 LITERATURE REVIEW

As people became aware of the seriousness of environmental issues for the first time in the 1960s a common question was-How long do we have? How long will it be before we reap the tragic consequences of our environmental disregard? The answer was 30 to 35 years. As we are beginning to experience a hotter climate, holes in the protective ozone layer over the poles, toxic chemicals in ground water throughout the nation, famines in Africa, food contaminated with pesticides residues and extinction of untold numbers of species as forests recedes.

Thousands of lakes are now lifeless and tens of thousands more are threatened and forest are dying back because of acid rain, which is occurring due to the regular emission of tons of sulphur dioxide in the atmosphere from power plants and other industries to meet the requirement of ever growing population. The climate is warming threatening the world with unprecedented droughts and other climate shifts because of increasing carbon dioxide and other "green house gases" in the atmosphere. All life on earth may be threatened by increasing ultraviolet radiation due to the depletion of ozone shield.

The multiplying human population had their requirement from the capital available in the system. This paved way to slow but steady attack on the stability of the ecosystem. Because of population growth, each society would have reached the point where resources of its territory could not have supported any more people. Migration was a natural solution to the problem. Prior to the discovery of the technique of the plant cultivation and animal domestication approximately ten thousand years ago, men everywhere were forced to rely on the uncertain boundary of nature. Wild animals were hunted and wild plants collected but man had no control over their food supply.

The discovery of the new technique of food production proved to be the basis for the first major social revolution in human history. Due to over population demand for more necessities increased, which enhanced rapid industrialization and urbanization.

Paul Haffman (1971) has observed "we have used up this Planet's natural resources at a frighteningly reckless rate. We have so polluted the atmosphere, the hydrosphere, and the

lithosphere, that with almost every breadth of air and with every bite of food we also too often ingest an assortment of environmental poisons." The prime destroyer of the delicate ecosystems is pollution in its ominous form, with rising tempo of industrialization in the years to come.

All these development were also accompanied by the domination of "economics" over every other thinking and the every single country, state and group of human society engaged themselves to achieve as much of "economic-development" as possible. The principle motivation force behind the economic development, according to Prof. Rathore, (1979) is the human aspiration factor which is progressively multiplied with every burst of human population. As man's environmental demands increase, the scales of environmental responses will expand. Thus the relative importance of strategic aspect of environmental planning will increase (David, 1974).

There is a sharp increase in the anthropogenic effect on the natural environmental caused by increasing pressure on natural resources by industrialization and urbanization. Along side the material benefits for the society. These processes have produced harmful pollution in its various forms and growing shortage of natural resources.

The environment includes the natural environment of air, water, soils and organisms which provide the setting in which a plant or animal lives; the "built" Environment that includes the urban and industrial establishments and the "social" environment relating to culture, law, economics etc. (Roberts and Roberts, 1984).

"The late 1960's and early 1970's witnessed an expanding almost explosive interest in the environment. Environmental problems were the concern of man in the street and they were the subject of hundreds of magazine, articles and books "(Smith 1976).

In the decade of 1970's the environmental scene was dominated by fear and concern. This decade witnessed a vigorous interest in the regional and global ecology. Water pollution, air pollution etc. but deforestation continued unabated and wildlife habitats were destroyed. Species disappeared completely at a rate of one every day.

Growing awareness about the state of our "natural" environment today has resulted in the increased focus on interactions between development projects and their effects on the

environment. Assessments of projects have concentrated only on their technical feasibility and economic viability. With our increased concern about the degradation of our environment, it is apparent that a more comprehensive approach to the evaluation of projects is necessary wherein environmental as well as economic consideration are given proper weight in the decision making process.

Environmental problems could include noise, air and water pollution (Van der Merwe, B 2008). It is essential to study Ambient Air Quality Status, Water (Surface Water & Ground Water) quality, Noise level to carry out EIA study

**Assessment of ambient air quality** is of paramount importance to understand the background of air quality before starting any new activity. Unplanned Industrial activity and urbanization is generally considered to be an environmentally unfriendly activity as it produces all categories of the wastes, i.e. , solids, liquids and gases. Particulate matters and gases when discharged in to atmosphere causes air pollution.

An industrial activity as well as mining activity can be considered as an area sourced for suspended particulate matter (SPM). Vehicular traffic in a haul roads of open cast mines have been identified as most prolific source of fugitive dust and can contribute as much as 80% if dust emitted from a surface coal mine (Dubois, L. and Monkman, J.L., 1984).

Reed et al. (2001) concluded that hauling operations contributed the majority of PM10 concentrations and that the haul truck emissions factors may be part of the cause of the over prediction of PM10 concentrations by the ISC3 model.

In addition to industrial activity urbanization leads to high traffic volumes and heavily travelled highway corridors (Peace et al. 2004; Zeka et al. 2005). High levels of vehicle-related emissions have been linked to high density traffic sites (Campbell et al. 1995). Street canyons (streets lined with tall buildings that impede the dispersion of air pollutants) and areas very close to busy roads typically have a high concentration of emissions (Hoek et al. 2002; Kaur et al. 2006; Longley et al. 2004).

These areas may also contain a high concentration of people, including pedestrians and cyclists, or people within buildings alongside the road. Individual drivers or passengers of cars are also exposed to vehicle-related emissions. Individuals at all stages of their life

are at risk from traffic pollution, however, the severity of the hazard varies with age and underlying medical conditions.

Campbell, Monica et al. (2007) reported that major source of both primary emissions and precursors of secondary pollutants, vehicle traffic greatly contribute to the overall impact of outdoor air pollution.

**Water** is a vital essential commodity necessary for the survival of vegetation, animals and human beings and for proper balance of eco system itself. Hence it is necessary to study the quality of water in the study area to find out if industrial activities in and around the area have caused any deterioration in the environmental quality with respect to surface and ground water sources, so that the health and growth of humans, flora, fauna and soil conditions are not affected adversely.

Water is one of the most common yet the most precious resources on earth without which there would be no life on earth. Yadav S. S. et al (2011) reported that water pollution is a serious problem as 70% of India's surface water resources and as growing number of its ground water reserves have been contaminated by biological, organic and inorganic pollutants. The main cause of water pollution is human activities. Humans produce bodily wastes that enter the river and polluted water.

In south Asian countries such as Nepal, India and Bangladesh, pollution of rivers is more severe and critical near urban stretches due to huge amounts of pollution load discharged by urban activities.

Karn, S. K. & Harada Hidki (2001) reported that South Asian countries such as Nepal, India, and Bangladesh, pollution of rivers is more severe and critical near urban stretches due to huge amounts of pollution load discharged by urban activities. The Bagmati River in the Kathmandu valley, the Yamuna River at Delhi, and peripheral rivers (mainly Buriganga River) of Dhaka suffer from severe pollution these days. Unplanned urbanization and industrialization occurring in these cities may be largely responsible for this grave situation. Inadequate sewerage, on-site sanitation, and wastewater treatment facilities in one hand, and lack of effective pollution control measures and their strict enforcement on the other are the major causes of rampant discharge of pollutants in the aquatic systems.

The availability of water determines the location and activities of humans in an area and our growing population is placing great demands upon natural fresh water resources (Oladipo M.O.A et al., 2011).The natural aquatic resources are causing heavy and varied pollution in aquatic environment leading to water quality and depletion of aquatic biota. Water sources were polluted by domestic wastage in rural areas whereas industrial wastages discharged into natural water sources in urban areas (Sayyed J.A. et al., 2010).

Today there is trace contamination not only of surface water but also of groundwater bodies, which are susceptible to leaching from waste dumps, mine tailings and industrial production sites (Moore P. D., Daniel Jr. T. C. et al., 1998). Water quality reflects the composition of water as affected by natural cause and man's cultural activities expressed in terms of measurable quantities and related to intended water use (Kumar N., 1997).

The composition of surface and groundwater is dependent on natural factors (geological, topographical, meteorological, hydrological and biological) in the drainage basin and varies with seasonal difference in runoff volumes, weather conditions and water levels (Muller B.A. et al., 2001).

One of the major reasons of ground water pollution in India is unplanned urban development without adequate attention to sewage and waste disposals (Yadav S.S. et al, 2011).

**Noise** is a natural consequence of whatever we do. It forms of our everyday background and for the most part we just accept it or at least tolerate it. However, noise has the capacity to cause conflict between those who are generating it and those who are subjected to it but who do not wish to be (Saenz & Stephens, 1986).

Environmental noise is unwanted or harmful outdoor sounds created by human activities, including noise emitted through means of transport (e.g. road traffic, air traffic) and noise from sites of industrial activity (Goines & Hagler, 2007)

Noise will continue to increase in magnitude and severity on account of present societal trends namely population growth and urbanization. Its severity will intensify, in relation with the increase in the use of progressively more powerful, varied, and highly mobile

sources of noise. Noise levels will also continue to rise with sustained growth in highway, rail, and air traffic, the major sources of environmental noise (Schell et al, 2006).

Environmental noise pollution may not pose the threat of immediate destruction that nuclear war does, but one should bear in mind that the effects are the same and just as lasting (Dooley, 2002).

Escape from human-induced sound is markedly more difficult today than a century ago, and within another half –century it may be all but impossible. One might wellask how human-kind arrived at the present state of affairs. Several causative factors would seem to be responsible (Schell et al, 2006).

The words that are constantly heard in the media and academic circles are "climate change and global warming". These words are associated with studies based on carbon dioxide emissions and excessive heat. Accordingly to manmade thinking , generally, humans do not believe that the noise impacts upon the total environment. They instead believe that fairly common atmospheric pollutants have more extreme consequences for the planet as opposed to noise. (Fyhri & Klaeboe, 2006).

However , the noise problems of the past are incomparable to those of modern society. A massive number of motor cars are constantly travelling through our cities and the countryside, while heaviely-laden trucks with diesel engines, which have been ineffectually silenced for engines and exhaust noise, weave about in our cities day and night (Schwela & Zali, 1999).

A number of factors contribute high noise levels, such as an increase in population and an increase in the volume of traffic. (Department of Environment & Climate Change, 1995).

However greater community awareness of environmental noise has increased and there are greater expectation now for state and local govt. to reduce noise levels. (Singh & Rao, 2001)

Urban noise pollution has rapidly grown to become a significant environmental problem.(Bragdon, 1971). Bragdon, C.R.(1978)

**EIA METHODOLOGY**

The environmental systems are characterized by complexly linked components which make the task of identifying and predicting the impacts quite difficult. The salient features of the methods available for EIA are briefly given as under :

## 1. Adhoc Approach

Adhoc Approach procedure is one of the oldest methods prior to which no systematic evaluation was available. This method involves formation of multidisciplinary team which identifies very broad areas of the environment that might be impacted and also, the possible nature of impacts in a very generalized way. A good example of this approach is given by Rau (1980). It considers each environmental area being impacted by a particular project. Environmental components are arranged in rows and effects of impacts are arranged in columns. The impacts are written in terms of Positive (+), negative (-), no effect, problematic, beneficial, adverse, short term, long term, reversible and irreversible etc.

Adhoc approach is highly subjective as the percent of imagination is high and the results differ from person to person, It does not take secondary or higher order impacts in account. It does not provide to person specific information and objective rating is poor.

## 2. Overlay Method (1971) (I.McHard,1971)

The overlay method is an cartographic technique which is based on the super-imposition of a number of transparent maps. This method is flexible and efficient. It involves the selection of important environmental and social characteristic of the given area. Each characteristic is then displayed over a transparent map and shaded in a manner that shows how much compatible that characteristic is to the proposed action. A final composite map is then produced by superimposing all transparent maps. Impacts are identified by locating project activity on this composite map.

Overlay method is unable to bring out the higher order impacts. Number of selected parameters would be limited to prepare the final composite map and avoid difficulties in it. It shows qualitative changes but not the quantitative.

## 3. Checklist Method (Scaling) (1971) (Adkins, W.G. & Burke, 0. Jr., 1871)

Checklists are basically extensions of Adhoc-Approach. The emphasis in checklists is on those areas of environment which are likely to be impacted. The nature of the impacts is generally assessed decrepitly but methods to quantify checklists have also been developed. It involves the evaluation of specific environmental parameters on a checklist for impacts using a -5 to +5 scale. After constructing the comparative checklist environmental scores are put. In this method parameters are kept in rows and potential impacts are in columns. The checklists for comparison of construction phase and operational phase can also be prepared. Then scores are aggregated by the arithmetic addition and the resultant scores are used to compare alternatives. Checklists have been classified by Canter (1977) as simple checklist, descriptive checklists, scaling checklists and weigh scaling checklist.

In this method difference between more or less important impacts can not be evaluated as the impact is weighed equally. It ignores the higher order impacts.

### 4. Matrix Method (1971) (Leopold, L.B., Clarke, F.E.; Hanshaw, B.B and Balsley, J.R.; 1971).

The matrix method was initially developed by LeoPold et al. (1971). In this method a matrix format is to relate project action and environmental components. Horizontal axis on the columns consist of 100 project actions, while the vertical axis or rows of the matrix of 88 environmental components. For magnitude of impact an appropriate call is scored. In which 10 values placed in upper half of the cell for magnitude and the importance of impact 1 to 10 on the lower half of the cell A + or – sign is put to designate the harmful or beneficial nature of impact. The total of a column Indicated the impacts of one action on all environmental components while the total of a row represents the impact of all the project action on one environmental component. The total of all cells in the matrix brings out the total weighted impact of the project along with its harmful or beneficial effects on the environment.

The method brings out only the direct impacts and ignores the indirect ones. Rose (1974) had develop the “component Interactional matrix” or CIM method to overcome this drawback.

### 5. Optimum Pathway Matrix (1971)

**(Odum, E.P., Zieman, J.C., Shugart, H.H., Ike A and Champlin, i.R. 1971).**

The method was initially designed to evaluate impacts of eight alternative highway routes. A list of 56 environmental parameters to be considered was made. The units of measured values of these attributes was different, they were put on a scale 0-1 by assigning a value of 1 to 10 the maximum, input of any alternative by the maximum values.

To scale them accordingly each of the 56 parameters was scaled in a similar fashion. Impacts resulting as such were multiplied by a weighting factor that designated relative Importance on a 0 to 10 scale, which was subjectively established by the panel. A weight was added to these initial values for long term effects multiplicated by 10. The long term effects were treated 10 times more important.

The method has received considerable attention due to the identification of the indirect impacts or impacts. The method visualizes a number of basic activities and constructs a series of impacts as a result of these activities.

A plus (+) sign was used to designate beneficial impacts and a minus (-) sign to designate harmful impacts, finally composite scores were calculated for each of the alternative routes by aggregating individual impacts.

Due to the subjectively derived weighting factors, the method could lead to incorrect results. This was accounted for by setting confidence limits on the totality of the indicators by re-computing data with assumption of up to 50% error in subjective derived weighing factor.

## 6. Sorenson's Network Analysis (1971) (Sorenson, J., 1971)

The method has received considerable attention as it allows identification of the indirect impacts or Secondary impacts. The method visualizes a number of basic project activities and constructs a series of impacts generated as a result of these activities. Sorenson illustrates the approach by creating possible network of changes in response to 55 coastal zones using a matrix format with the land use type in the row of the matrix (vertical axis)

and five columns. Changes associated with a land use type are brought out (columns) to fill in:

(a) Casual factor- action associated with that land use that will occur.
(b) Initial condition- relating to primary impacts as a result of above activity.
(c) Consequent condition- higher order impact related to primary impacts.
(d) Effect- final effects of the impact chains.
(e) Control mechanism- suggestion of measures to mitigate harmful effects.

The objective of network approach is to display in an easily understood format that Intermediary link between project and its ultimate impacts (Shopley and Fuggle, 1984).

In this method cause- effect chains do not bring out the magnitude of Inter-relationship between components or extent of change (Wathern, 1984).

## 7. **Computer Modeling Process (1972) (Krauskopf, T.M. and D.C. Bunde, 1972)**

This method is essentially a computerized version of the overlay technique. The computer stores data on a grid system of 1 $km^2$ cell for a large number of environmental parameters. Alternative with least impact out of a given set of routes can be stored by the computer or even new alternative with lesser Impacts can be generated.

## 8. **KISM (The Kane Ian Simulation Model (1973) (Julius Kane, Ian Vertinsky and Willeam, Thompson, 1973)**

KISM begins with the formation of an interdisciplinary analysis group that identifies a set of significant variables that can describes the system with reasonable accuracy. The study team determines initial values, threshold (minimum) levels, and saturation (maximum) levels for each variable. This range is scaled to an open interval expressed as a percentage between 0-100. The group then construct an interaction matrix in which rows and columns both contains the list of selected variables.

Participants score the strength and direction of relationship for each possible interaction through a Delphi process on a numerical scale-3 to +3. The computer produces a graph of interaction among variables assuming a no linear growth curve.

## 9. **Environmental Evaluation System (1973)**

**(Dee, N.et al., 1973)**

EES method is one of the most quantitative and organized method in EIA. This method visualizes 78 measurable environmental parameters divided in four categories : ecology, environmental pollution, esthetics and human interest. In this firstly parametric values are transformed into an environmental quality (EQ) scale that ranges between 0-1 where 0 denotes extremely bad quality and 1 denotes very good quality. This transformation is achieved through value function graph developed for each of the 78 parameters. Values are shown on the abscissa and the environmental quality (0-1) is on the ordinate. Thus after the completion of this stage, each parameter acquire a EQ value between 0-1. The approach recognizes that all the 78 parameters used to describe the total environment are not of equal importance. For the relative importance of parameters each parameter is assigned a parameter importance unit (P.I.U.) i.e. 1000. The second stage involves the multiplication of the EQ value of parameters with their PIU values to obtain commensurate environmental impact unit (EIU) for each parameter. The second stage involves the multiplication of the EQ value of parameters with their PIU values to obtain commensurate environmental impact unit (EIU) for each parameter. The final step involves the aggregation of the EIU values for a composite score.

The EES is used or evaluating the expected future conditions of the environmental quality 'without' the project and then with project. A different in environmental impact unit (EIU) between these two conditions constitutes either an adverse or beneficial situation (Dee).

## 10. Fischer and Davies Matrices (1973)
## (Fisher, D.W. and G.S. Davies. 1973)

This method expands the concept of matrices. The environmental feasibility is identified and evaluated in three steps.

A. A matrix for environmental evaluation in terms of importance, present condition and management .

B. An environmental capability matrix in terms of importance, present condition and management

C. A decision matrix for evaluating alternatives available (Viohl and Mason. 1974).

Chase (1976) categorizes it as numeric. The matrix is filled using one score on a scale of -5 to +5 to indicate both positive and negative degrees of impact.

## 11. Peterson Matrix (1974) (Peterson, G.L., Gemmel, R.S. & Schofer, J.L., 1974)

The matrix is a mathematical matrix that make use of multiplication properties of matrices to bring out secondary impacts to a certain extent. The method involves construction of two matrices and their consequent multiplication, to bring out the effect of the project on human environment.

The following steps are involved in execution of the method.

1. First matrix construction to evaluate impacts of projects of project action on the physical environment.
2. Second matrix construction evaluate impact of effected physical environment as human health.
3. The entries are put on a scale of -3to+3 by a team of expert involved in analysis.
4. First and second matrices are then multiplied to bring out the impact of project on human environment.
5. This product matrix is further multiplied by a vector of human impact weights, the result of which are aggregated in the form of an overall score representing the project impacts.
6. Consideration of secondary impacts is incomplete in this method.

## 12. Component Interaction Matrix (1974) (Ross, J., 1974)

The method aims at revealing higher order interaction of environmental component in a given set making use of simple matrix multiplication. The rows and columns of this matrix consists of identical set of environmental component. Direct dependencies between components are identified and scored in the appropriate cells. If matrix is

squared the second order impact will surface. Repeated multiplication of the ordered impacts will surface. Interrelation up to any order can be found.

## 13. The Environmental Quality Assessment (EQA) (Duke K.M. et al, 1977)

The environmental quality assessment (EQA) is the modified version of the EES. This method relies less on numerical weighting and indices but stresses on physical measurement and qualitative description of impacts. The execution of EQA involve steps as follows:

A. Formation of a multidisciplinary team which identifies relevant environmental components (factors) and binds each in space and time. Matrix is used to complete selection of factors.

B. These parameters are measured as baseline. The data for tem is acquired and projection for future condition made and entered in appropriate physical units.

C. Finally environmental effect is termed as the difference between with and without project effects.

## 14. Computer Aided Environmental Impact Analysis (1977) (Jain, R.K. and Webstar, D.Ronanld., 1977)

This was developed at the U.S. army to comply with the complex requirement of NEPA. This consists of three system to aid EIA pertaining to army activities. These systems are:

### a. Environmental Impact Computer System (EICS)

It is umbrella system which identifies potential environmental impacts by relating army activities (divided into 9 functional areas) to environmental attributes (divided into 13 categories). This also provides mitigation statements specifying common methods and procedures to reduce magnitude of impacts.

### b. Economic Impact Forecast System (EIFS):

It provides quantitative estimates of regional economic impact of army action based upon an extensive diverse interaction data base.

### c. **Computer-Aided Environmental Legislative Data System (CELDS):**

It stores abstract of pertinent environmental legislation. The user specifies his area of interest and computer itemizes all environmental laws, regulation and standards that pertain to that given area.

## 15. **Adaptive environmental Assessment (1978) (Holling C.S., 1978)**

This is applicable to different environmental situation and varying project as its name indicates. The method instead of being rigid on predefined set of rules is an adaptive process which caters to assessments needs of varying situations. A brief description of the process in the following steps :

a) Appointment of a project manager and multidisciplinary team.

b) The team conducts workshops acquire information relevant to them and develops a system model which at this stage may not be mathematical. This reflects important system attributes.

c) The consequent step involves simplification validation of the model; special importance is given to sensitivity analysis.

d) Evaluation of alternative models runs with communication of information graph and pictorials.

## 16. **Ecological Framework for Environmental Impact Assessment (1988) (Beanland, G.E. and Peter N. Duniker)**

It is based on ecological principles and not well defined for EIA yet. The steps are:

a) Early identification of an initial set of valued ecosystem components to provide focus for subsequent activities.

b) Definition of the context within which the significance of changes in the valued ecosystem components can be determined.

c) Establishment of temporal and spatial context for the study and analysis of expected changes in valued ecosystem components.

d) Develop an explicit strategy for investigating the interaction between the project and each valued ecosystem component and demonstration of how the strategy is to be used to coordinate individual studies undertaken.

e) State impact predictions explicitly and accompany them with basis upon they were made.

f) Demonstrate and detail a commitment to a well defined programme for monitoring project effects.

## 17. **Social Judgement Capturing Adaptive Goals Achievement-Environmental Assessment Method- SAGE (1984) (Hyman, E.L. Moreau, D.H. and Stiftel, B., 1984)**

This basically concentrates on eliciting and incorporating values weights of a broad array of group in multi-objective making. It's execution involves four steps:

a) Predicting the physical, chemical and biological attributes of alternative action.

b) Scaling the attribute into accounts of beneficial and adaptive effects on the objectives.

c) Facilitating relative value weight that individual or group assign to each objective.

**Presenting** finding in a form useful to the decision maker.

# 3 METEOROLOGICAL DATA

The meteorological data for Wind speed, wind direction; temperature, relative humidity and general weather conditions is recorded at site and historical data is collected from nearest IMD Station along with the data from earlier EIA.

The summary of the 30 years data as recorded by IMD station at Bareilly is given in Table 4.1 below**.**

Table 4.1: Summary of the 30 years data at IMD Bareilly station

| **PARAMETER** | **Avg. Maximum** | **Avg. Minimum** |
|---|---|---|
| Pre-monsoon (Mar-Apr-May) | | |
| Temperature (°C) | 37.8 | 20.4 |
| Relative Humidity (%) | 59 | 24 |
| Average Wind Speed (kmph) | 6.9 | |
| Wind Direction | W, NW & E | |

Pre-monsoon (Mar-Apr-May)

- Temperature: During the pre-monsoon season, the average maximum temperature was 37.8 $^0$C and minimum temperature was 20.4 $^0$C.
- Relative Humidity: The maximum relative humidity of the area was found to be 59%.
- Wind Speed: The mean wind speed was 6.9 kmph.
- Wind Direction: The predominant wind direction was West, followed by North-west and east.

On-Site Meteorological Data

The meteorological data for Wind speed, wind direction; temperature, relative humidity and general weather conditions were recorded throughout the study period. The climatology details & summary of study period for the nearest IMD station & On-Site Micro-Meteorological data summary are given in Table 1 & Table 2 to Table 4 respectively.

# 4 STUDY ON AIR ENVIRONMENT

## 4.1 Introduction:

Assessment of ambient air quality is of paramount importance to understand the background of air quality before starting any new activity. This section describes the selection of sampling locations, methodology adopted for sampling, analytical techniques and frequency of sampling. The secondary data with respect to ambient air quality is also reviewed from published reports and earlier EIA.

## 4.2 Methodology:

### Selection of Sampling Stations

The baseline status of the ambient air quality is assessed through a scientifically designed ambient air quality-monitoring network. The design of monitoring network in the air quality surveillance program is based on the following considerations:

- Meteorological conditions on synoptic scale.
- Topography of the study area.
- Representatives of regional background air quality for obtaining baseline status.
- Representatives of likely impact areas.

In order to establish the baseline air quality status in a study area, about 10 ambient air quality stations were selected within the 10 Kms radius study area of the proposed project site including one station in downward direction as per the earlier EIA. These stations were selected on the basis of even distribution over the study area taking in to consideration various factors like topography of the region, proximity of sensitive establishment and human settlements, industrial activities in the area and its proximity, down wind direction etc. The primary sources of suspended particulate matter in the ambient air environment of industrial area of Kashipur are from transportation of heavy vehicles and industrial activity. Details of ambient air quality monitoring stations are given below.

A monitoring station (base station) was located at **near A-1 Industrial Area** which is around 7 km east of Kashipur city. Uniqueness of this station is the fact that we are taking it as base station and all other station are within 10 km radius of this station.

**Ginni Khera** is a very small village located around 3 km north east of Prolific Papers (P) Limited. Uniqueness of this station is that, it is away from industries (except one paper plant) and city. The selected study station is considered to be agriculture land and exhibit intense agri-business and ruler activity.

**Nandrampur** is a village located around 2 km north east of India Glycols and around 500 m north east of Highway .Uniqueness of this station is the fact that it in down wind direction of chemical industry and highway. There is heavy traffic of heavy vehicles in the highway due to industrial transportation through this region.

**Dhakia Kalan** is a village located around 7 km north east of India Glycols and around 6 km north east of Highway .Uniqueness of this station is it is away from industries thus it can be use for reference data.

**Dabhaura Mustahkam** is a village located around 3.5 km south east of India Glycols and around 2.5 and 2 km east of Chima Paper and Multiwall Paper respectively. Uniqueness of this station is the fact that it is in up wind direction of paper and chemical industry and highway. This station has taken as reference station providing background level.

**Barkheri** is a village located around 2 km west of Chima Papers and around 2 km South of India Glycols Limited. Uniqueness of this station is the fact that it is affected with pollution load of paper and other industry and unpaved road.

**Berkhera Pandey** is a village located in the west of Shravanti Energy and North of Flexi Tuff. Uniqueness of this station is the fact that it in down wind direction of Flexy Tuff.

**Kharakpur Devipura** is a village located around 4 km west of India Glycols Limited and in between India Glycols Limited and Kashipur City. Uniqueness of this station is that, it is away from industries and city. The selected study station is considered to be agriculture land and exhibit intense agri-business and ruler activity.

**Kashipur station** is located at the telephone exchange building of Kashipur. Uniqueness of this station is that, it will represent the pollution load of local transportation as it is adjacent to highway. The selected study station is considered to be the major traffic intersections area of the city and exhibit intense human activity.

**Gangapur gosain** is located in approximately 6 km north of India Glycols Limited. Uniqueness of this station is that, it will represent the pollution load of ruler activity. The selected study station is considered to be agriculture land and exhibit agri-business.

**Table 5.2.1: MONITORING STATIONS FOR AMBIENT AIR QUALITY**

| Sl. No | CODE | LOCATION | DIRECTION | DISTANCE |
|---|---|---|---|---|
| 1 | AAQ-1 | On Site | | |
| 2 | AAQ-2 | Ginni khera | W | 6.8 |
| 3 | AAQ-3 | Dhakia kalan | NE | 8.5 |
| 4 | AAQ-4 | Dhabora mustakham | SE | 5.0 |
| 5 | AAQ-5 | Barkheri | S | 4.6 |
| 6 | AAQ-6 | Barkera pande | SW | 6.9 |
| 7 | AAQ-7 | Nandrampur | NE | 3.8 |
| 8 | AAQ-8 | Kharakpur devipura | NW | 3.0 |
| 9 | AAQ-9 | Kashipur | NW | 9.0 |
| 10 | AAQ-10 | Gangapur Gosain | N | 6.0 |

The details of these Ambient Air quality-sampling stations are given below.

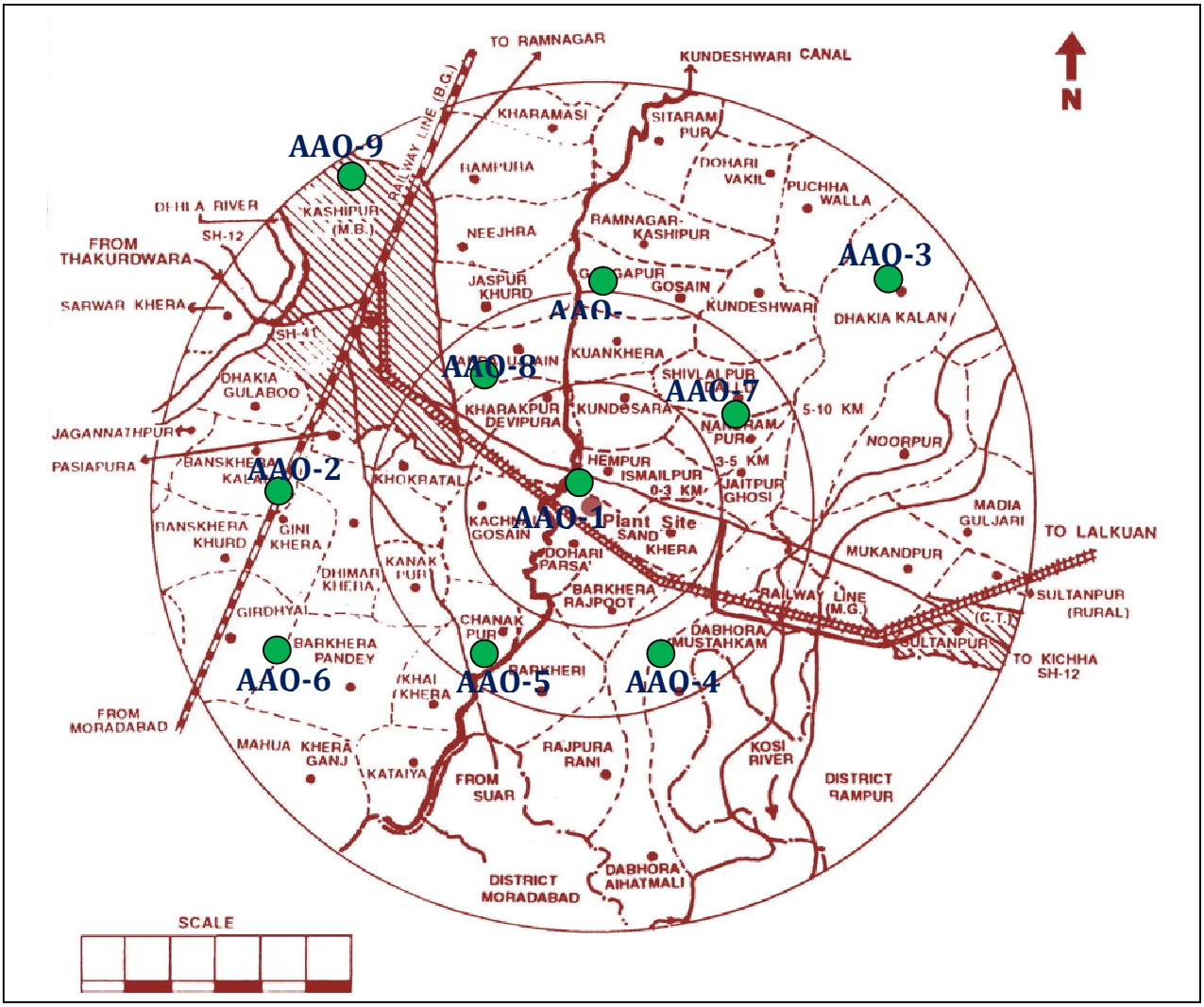



**Fig 5.2.1: MONITORING STATIONS FOR AMBIENT AIR QUALITY**

**Frequency and Parameters for Sampling**

Ambient air quality monitoring is carried out with a frequency of two samples per week at three to four locations in a day. The baseline data of ambient air is generated for the following parameters as mentioned below. Most of the parameters are selected as per earlier EIA and as per EIA Notification, 2006.

- Suspended Particulate Matter

- PM10
- PM 2.5
- Sulphur Dioxide (SO2)
- Oxides of Nitrogen (NOX)

**Sampling Methods**

**Instruments used for Sampling**

Respirable Dust Samplers APM-451 of Envirotech Instrument Pvt. Ltd. make was installed for monitoring Suspended Particulate Matter (SPM), Respirable fraction (<10 microns) and gaseous pollutants like SO2 and NOX. Whereas the concentration Particulate matter 2.5 was monitored by installing Envirotech made APM 50MFC particulate matter sampler. Mercury in ambient air was monitored by electro-thermal atomic absorption spectrophotometric method. The dust samples for mercury analysis was collected on EPM 2000 filter papers using respirable dust high volume samplers.

**Sampling and Analytical Techniques**

The techniques used for ambient air quality monitoring are given in the **Table**

**Table 5.2.2: TECHNIQUES USED FOR AMBIENT AIR QUALITY MONITORING**

| Parameter | Technique |
|---|---|
| 1. Suspended Particulate Matter | Respirable Dust Sampler (Gravimetric method) |
| 2. PM 10 | Respirable Dust Sampler (Gravimetric method) |
| 3. PM 2.5 | APM 550 Fine Particle Sampler |
| 4. Sulphur Dioxide | West and Gaeke |
| 5. Oxides of Nitrogen | Jacob and Hochheiser |

**4.3 Result and Discussion.**

The level of air pollutants were observed at considerably lower level, due to dust suppression and dissolution of gaseous pollutants naturally, by precipitation due to humid atmosphere. Air pollution status and its assessment, is provided below:

Average concentration level of SPM, PM10, PM2.5, SO2 and NOX, as observed are presented in Table 5 to Table 9 & Figure 1 & Figure 2 reflecting air quality in the study area.

Significant level of SPM can be observed in Kashipur City, Barkheri village and at industrial area. The highest level of SPM can be observed at Kashipur city due to intense human activity and traffic intersections, and second highest SPM observed at Berkheri is mainly due to unpaved road. Third highest SPM is found at industrial area due to coal storage & movement of coal and industrial boiler activity in the area. Still the SPM level of all these are well below the NAAQS.

Significant level of RPM (PM10 & PM2.5) can be observed in Kashipur City, Kharagpur Devipura village. The highest level of RPM is observed at Kashipur city due to intense human activity and traffic intersections consist of transportation on highway, and second highest RPM observed at Kharagpur Devipura village is mainly due to agriculture land and exhibit intense agri-business and ruler activity and unpaved road. Agriculture activity will cause emission of fine dust. Third highest RPM is found near industrial area due to storage of coal, movement of coal industrial boiler activity in the area. Higher RPM is monitored at two more monitoring station Ginni Khera and Gangapur Gosain and these higher RPM level is due to agriculture land and exhibit intense agri-business and ruler activity and unpaved road. Agriculture activity cause emission of fine dust. Still the RPM level of all these are well below the NAAQS.

Significant level of $SO_2$ is observed in Kashipur City and near industrial area. The highest level of SO2 can be observed at Kashipur city due to intense human activity and traffic intersections consist of movement of vehicles at highway. Higher $SO_2$ level is found near industrial area due to industrial activity and coal fired boiler for steam and power generation. Emission of $SO_2$ due to movement of heavy carriage vehicles carrying raw materials and finished products. Still the $SO_2$ levels of all these stations are well below the NAAQS.

Significant level of NOX is observed near industrial area and at Kashipur City. The highest level of NOX observed on site near industrial area due to industrial activity mainly coal fired boiler for steam and power generation. Emission due to movement of heavy carriage vehicles for carrying the raw material and finished product also increase the level of NOx in the area. The higher level of $NO_X$ observed at Kashipur city due to intense human activity and traffic intersections consist of movement of vehicles at highway. Still the $NO_X$ levels of all these stations are well below the NAAQS.

### 4.3.1 Statistical analysis of Environmental Parameters in Ambient Air of monitoring station AAQ-9 Kashipur City between 1998 & 2011:

Based on the available monitoring report we have carried out statistical analysis of Environmental Parameter in Ambient Air of a monitoring station known as Kashipur city.

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting SO2 at ambient air of Kashipur City in year 2015 will be 20.7 µg/cu.m and in year 2020 will be 24.2 µg/cu.m if the source of emission will be increasing in the same rate. (Ref. Figure 7)

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting Suspended Particulate Matter (SPM) at ambient air of Kashipur City in year 2015 will be 190.5 µg/cu.m and in year 2020 will be 214.9 µg/cu.m if the source of emission will be increasing in the same rate. (Ref. Figure 8)

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data referring and expecting Oxides of Nitrogen at ambient air of Kashipur City in year 2015 will be 11.6 µg/cu.m and in year 2020 will be 10.3 µg/cu.m if the source of emission will be increasing in same rate. (Ref Figure 6)

## 4.4 Conclusion.

This study reveals that ambient air quality of Kashipur industrial area is presently within limit of NAAQS. As per statically analysis ambient air quality of Kashipur city, we have concluded that air quality status is deteriorating as level of SO2 & SPM in on increasing path.

# 5 NOISE MONITORING

## 5.1 Introduction:

The ambient noise levels equivalent for 1-hour duration at 10 different locations were recorded, keeping in view with the traffic movement and other noise generating activities in the region.

The general noise level increases in towns and cities increases, mainly due to traffic.

Chepesiuk, R. (2005) reported that Noise comes from many sources; the most significant source is from transportation, particularly traffic noise. Highway noise emanates from three sources: (a) the engine, (b) the exhaust, and (c) the friction vehicle of the tyres on the road. Once typical highway speeds are reached, the predominant noise from light trucks and cars is from the tire/road interaction. Heavy trucks produce a high volume of noise from all three sources even at low speeds. The level of road traffic noise depends on three factors:

(1) The volume of traffic

(2) The speed at which the traffic moves, and

(3) The number of trucks in the flow of traffic (Pelton, 1993). Generally, heavier traffic volumes, higher speeds, and greater numbers of trucks increase the loudness of traffic noise.

## 5.2 Methodology:

The details of the monitoring stations are given in Table 6.2.1 and illustrated in Figure 6.2.1. These are selected by considering earlier EIA.

**Table 6.2.1: MONITORING STATIONS AMBIENT NOISE**

| Sl. No | CODE | LOCATION | DIRECTION | DISTANCE |
|---|---|---|---|---|
| 1 | N-1 | On Site | - | - |
| 2 | N-2 | Ginni khera | W | 6.8 |
| 3 | N-3 | Dhakia kalan | NE | 8.5 |
| 4 | N-4 | Dhabora | SE | 5.0 |

| Sl. No | CODE | LOCATION | DIRECTION | DISTANCE |
|---|---|---|---|---|
| | | mustakham | | |
| 5 | N-5 | Barkheri | S | 4.6 |
| 6 | N-6 | Barkera pande | SW | 6.9 |
| 7 | N-7 | Nandrampur | NE | 3.8 |
| 8 | N-8 | Kharakpur devipura | NW | 3.0 |
| 9 | N-9 | Kashipur | NW | 9.0 |
| 10 | N-10 | Gangapur Gosain | N | 6.0 |

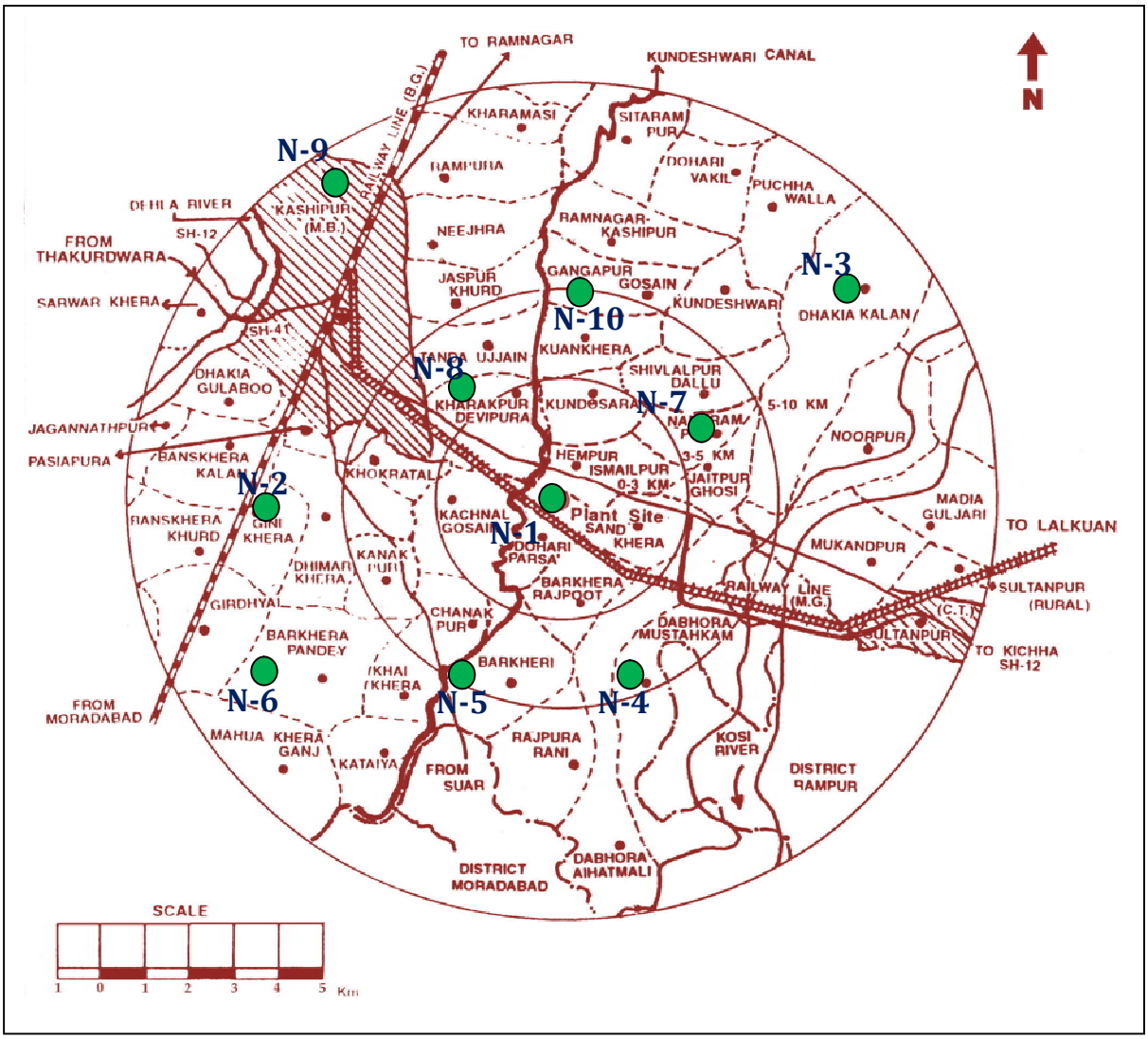



**Figure 6.2.1: MONITORING STATIONS FOR AMBIENT NOISE QUALITY**

### 5.3 Result and Discussion:

L MAX, L MIN, L eq, L10, L50 and L90, as observed are presented in Table 10 and Table 11 and in Figure 9 and Figure 10 reflecting Noise level in the study area for 2012

Noise level is found higher near study area N-9 (Kashipur city) and N-10 (Gangapur Gosain) and vehicular movement is important source of noise at both places. Noise level of monitoring station is found within limit.

The study area near N-1 (industrial area) experience a marginal increase in ambient noise level due to the construction activity, the traffic for loading, unloading, fabrication and handling of equipment. The marginal increase of Noise level is reversible and localized in nature and mainly confined to the day hours and still found within limit.

### 5.4 Conclusion:

Noise level is found within limit during monitoring at monitoring station.

# 6 STUDY OF WATER ENVIRONMENT

## 6.1 Introduction:

Water is a vital essential commodity necessary for the survival of vegetation, animals and human beings and for proper balance of eco system itself. Hence it is necessary to study the quality of water in the study area to find out if industrial activities in and around the area have caused any deterioration in the environmental quality with respect to surface and ground water sources, so that the health and growth of humans, flora, fauna and soil conditions are not affected adversely. This assessment serves as a baseline to compare with the post establishment data for taking necessary corrective measures; if at all any of the parameter tends to exceed the prescribed limit.

India has experienced substantial increases in industrial growth and expansion in recent years. The industry has resulted in increased pollutant emissions and the deterioration of environmental quality and human health in major cities in India. After formation of Uttarakhand as a new State rapid industrializations and urbanization took place due to this there is great pressure on the environmental components.

The main cause of water pollution is human activities. Humans produce bodily wastes that enter the river and polluted water. Industries discharge variety of pollutants in the waste water including heavy metals, organic toxins, oil nutrients and solids. Many of the substances are toxic or even carcinogenic. Pollution is a serious problem as 70% of India's water resources and as growing number of its water reserves have been contaminated by biological, organic and inorganic pollutants (Yadav, S.S., Kumar, Rajesh et. Al).

Human needs are growing rapidly and the need for water is also growing. Much of the current concern with regards to environmental quality is focused on water because of its importance in maintaining the human health and health of the ecosystem. The availability of water determines the location and activities of humans in an area and our growing population is placing great demands upon natural fresh water resources (Oladipo M.O.A et al., 2011).The natural aquatic resources are causing heavy and varied pollution in

aquatic environment leading to water quality and depletion of aquatic biota. Water sources were polluted by domestic wastage in rural areas whereas industrial wastages discharged into natural water sources in urban areas (Sayyed J.A. et al., 2010). It is therefore necessary that the quality of drinking water should be checked at regular time interval because due to use of contaminated drinking water, human population suffers from a variety of water borne diseases (Ogbonna O. et al., 2011). Fresh water is a finite resource, essential for agriculture, industry and even human existence, without fresh water of adequate quantity and quality, sustainable development will not be possible (Kumar N., 1997).

Thus Surface Water and Ground Water quality is studied separately in next chapter.

# 7 STUDY OF GROUND WATER ENVIRONMENT

## 7.1 Methodology

Water samples are collected from 10 locations for groundwater These water samples are analyzed in laboratory as per the methods described In IS: (3025-1964). The details of the ground water sampling locations are mentioned in Table and in Figure. Location of monitoring stations is as per earlier EIA with few additional locations to evaluate further areas. Kashipur has been identified as one of the potential Industrial developing area in Uttarakhand.

**Description of Study area with respect to impact on Ground water.**

The major sources of pollutants of Kashipur are domestic wastage due to unplanned urban development and industrial waste from the industrial activity paper industries and mining activity without adequate attention to sewage and waste disposals.

Total of 10 different locations were identified to collect the ground sample. Each such sited station represents a unique category of microenvironment. Sampling point selected based on the criteria mentioned below:

- Zone of possible pollutant concentration.
- Area of population exposure.
- Dispersion of pollutants from other sources located outside the study area.
- Non-Industrial reference station providing background level

Sampling points were selected within the 10 Kms radius of study area including one station in upstream direction. These samples were selected on the basis of even distribution over the study area taking in to consideration various factors like topography of the region, proximity of sensitive establishment and human settlements, industrial activities in the area and its proximity etc. Location plan of the sited Ground water monitoring point is presented in Figure below and each station site is briefly described below:

A-1 Industrial area is located around 7 km east of Kashipur city. Uniqueness of this sampling point is the fact that all other samples are collected within 10 km radius of this sampling point. Ginni Khera is a very small village located around 3 km of Prolific Papers (P) Limited. Uniqueness of this station is that, it is away from industries (except a paper plant) and city. The selected sampling point is considered to be agriculture land and exhibit intense agri-business and rural activity. Nandrampur is a village located near A-1 industrial area Kashipur. Dhakia Kalan is a village located around 7 km north east of A-1 industrial area. Uniqueness of this station is it is away from industries but mining activity has been noticed near this area, thus it can give impact of leaching from dumps, mine tailings. Dabhaura Mustahkam is a village located around 2.5 and 2 km east of Chima Paper and Multiwall Paper respectively. Barkheri is a village located around 2 km west of Chima Papers and around 2 km South of A-1 industrial area.. Kharakpur Devipura is a village located around 4 km west of A-1 industrial area and in between A-1 Industrial area and Kashipur City. Uniqueness of this station is that, it is away from industries and city. The selected study station is considered to be agriculture land and exhibit intense agri-business and rural activity. Kashipur sampling point represents the pollution load of domestic sewage penetrate to ground water. Gangapur gosain is located in approximately 6 km north of A-1 Industrial area. The sampling point is considered to be agriculture land and exhibit agri-business.

**Table 8.1.1: LOCATIONS FOR GROUND WATER SAMPLING**

| Sl. No | CODE | LOCATION | DIRECTION | DISTANCE |
|---|---|---|---|---|
| 1 | GW-1 | On Site | - | - |
| 2 | GW-2 | Ginni khera | W | 6.8 |
| 3 | GW-3 | Dhakia kalan | NE | 8.5 |
| 4 | GW-4 | Dhabora mustakham | SE | 5.0 |
| 5 | GW-5 | Barkheri | S | 4.6 |
| 6 | GW-6 | Barkera pande | SW | 6.9 |
| 7 | GW-7 | Nandrampur | NE | 3.8 |

| | | | | |
|---|---|---|---|---|
| 8 | GW-8 | Kharakpur devipura | NW | 3.0 |
| 9 | GW-9 | Kashipur | NW | 9.0 |
| 10 | GW-10 | Gangapur Gosain | N | 6.0 |

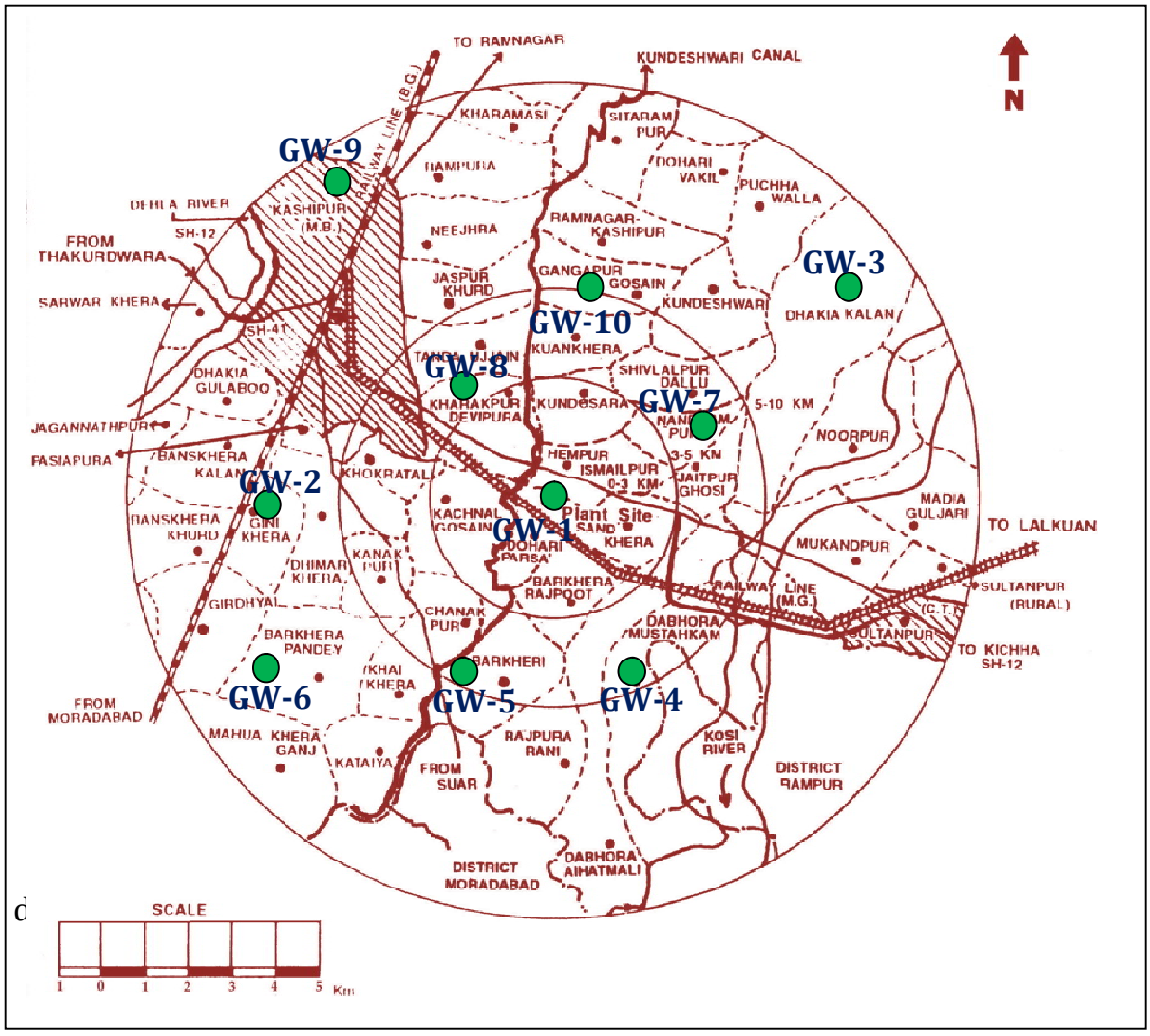



**Figure 8.1.1: LOCATIONS FOR GROUND WATER SAMPLING**

## 7.2 Result and Discussion:

The various parameters determined were pH, color, EC (electrical conductivity), total dissolved solids (TDS), total hardness (TH), calcium (Ca2+), magnesium (Mg2+), carbonate (CO3 2-), bicarbonate (HCO3-), chloride (Cl-), sulfate (SO42-), Sodium (Na+),

potassium (K+), Nitrate (NO3-), BOD(3 days at 27 degC), COD & Total coliform as observed are presented in Table 10 and Table 16 and Table 17. Average value of monitoring parameter is presented in Table 18.

Various physicochemical parameters such as pH, electrical conductivity, total alkalinity, total hardness as well as calcium, magnesium, sodium, potassium, chloride, nitrate, carbonate, and bicarbonate were analyzed with the determination of BOD, COD, total coliform and Fluoride. In general, the ground water had no colour, odour and turbidity except few samples.

**pH**: - The maximum value of pH of the water samples was recorded as 7.54 at station GW2 and minimum value of pH was recorded as 6.86 at station GW7. In general pH was within the limits of standard value. For drinking water source, a pH range of 6.5-8.5 is recommended.

**Turbidity**:-The present study shows the turbidity in the range of 0.2 -1.1 NTU. World Health Organization prescribed the highest desirable limit 5.0 NTU and maximum permissible limit 25.0 NTU. The value of turbidity present is within permissible limits.

**Total Alkalinity**: - The alkalinity of water is its capacity to neutralize acids. The maximum alkalinity was recorded as 172 mg/l at station GW1 and minimum value is recorded as 121 mg/l at station GW7. BIS has set a desirable level of alkalinity in drinking water to be 200 mg/l where as its value has been prescribed to be 600 mg/l in the absence of alternative source. So in maximum stations value of total alkalinity present in water are within limit.

**Total hardness**: - In the present study water samples of different locations was observed in the range of 115-240 mg/l. The amount of dissolved calcium and magnesium in water determines its "hardness." The hardness of water is not a pollution parameter but indicates water quality. Hardness has no known adverse effects on health. However, maximum permissible level prescribed by WHO for drinking water is 500 mg/L.

**BOD**: - Biochemical oxygen demand is usually defined as the amount of oxygen required by bacteria in stabilizing the decomposable organic matter. BOD gives an idea about the extent of pollution. In present study water samples, sampling stations BOD was found in

the range of 1.5-2.5 mg/l, it indicates that the pollution affects the water quality. As water can be use as drinking water without conventional treatment but after disinfection if BOD is 2 mg/l or less.

**COD**: - The chemical oxygen demand is a measure of oxygen equivalent to the requirement of oxidizing organic matter contents by a strong chemical agent. The COD test is helpful in indicating toxic conditions and the presence of biologically resistant organic substances. The maximum COD value was recorded 52.8 mg/l at GW1 and the minimum values was recorded as 25 mg/l at GW3. The high value of COD due to high level of pollutants present in water samples.

**TDS**: - In water, total dissolved solids (TDS) are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles. The maximum TDS value was recorded 414 mg/l at GW7 and the minimum values was recorded as 258 mg/l at GW6. The permissible limit of TDS of drinking water is 500 mg/L (WHO, 2004). The observation shows that the TDS is within the permissible range as prescribed by WHO (2004).

**Chlorides**: - Chlorides occurs in all natural waters in widely varying concentrations. The chloride contents normally increases as the mineral content increases. In present study the chloride concentration were found in the range of 13-28 mg/l. The maximum chloride contents were due to addition of natural contaminants and pollutants at industrial area. According to WHO, maximum permissible limit for chloride is 500 mg/L. The value observed in present study is in the range of permissible limit.

**Nitrate**: - The nitrate content of water bodies was found in the range of 0.13-0.32 mg/l. The highest value of 0.32 mg/l was recorded at station GW1 ( industrial area) while minimum at station GW6 (Barkhera Pande). The value observed in present study is in the range of permissible limit of drinking water standards of ICMR. (Limit of Drinking water as per ICMR 20 ppm and ISI 45 ppm).

**Sulphate**: - The sulphate content varies between 7.2 to 21.5 mg/l. The sulphate value was also found to be within the prescribed limits.

**Fluoride**: - The fluoride content in water is below detectable limit

### 7.2.1 Statistical analysis of Environmental Parameters in Ground water of GW-3 (Dhakia Kalan) between 1998 & 2011

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting Total Hardness as CaCO3 at GW3-Dakia Kalan in year 2015 will be 209.2 mg/l and in year 2020 will be 217.8 mg/l if the source of emission will be increasing similarly. (Ref. Figure 11)

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting Calcium hardness as CaCO3 at GW3-Dakia Kalan in year 2015 will be 209.9 mg/l and in year 2020 will be 253.8 mg/l if the source of emission will be increasing similarly. (Ref. Figure 12)

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting Sulfate as $SO_4$ at GW3-Dakia Kalan in year 2015 will be 5.4 mg/l if the source of emission will be increasing similarly. (Ref. Figure 13)

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting Total Hardness as CaCO3 at GW4- Dhabora Mustakham will be 168.4 mg/l (in year 2015) and 163.6 mg/l (in year 2020) if the source of emission will be increasing similarly. (Ref. Figure 14)

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting Calcium Hardness as CaCO3 at GW4- Dhabora Mustakham will be 172.0 mg/l (in year 2015) and 201.1 mg/l (in year 2020) if the source of emission will be increasing similarly. (Ref. Figure 15)

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting Sodium at GW4- Dhabora Mustakham will be 34.2 mg/l (in year 2015) and 34.3 mg/l (in year 2020) if the source of emission will be increasing similarly. (Ref. Figure 16)

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting Potassium at GW4- Dhabora Mustakham will be 32.8

mg/l (in year 2015) and 42.6 mg/l (in year 2020) if the source of emission will be increasing similarly. (Ref. Figure 17)

### 7.3 Conclusion.

The result revealed that there was significant variation in some physicochemical parameters and most of the parameters were in the normal range and indicates better quality of ground water. It has been found that the water is best for drinking purpose in all the areas. In general all the parameters are within the range of standard values prescribed by various agencies.

# 8 STUDY OF SURFACE WATER ENVIRONMENT

## 8.1 Methodology

Water samples are collected from six locations for surface water monitoring. Sampling location are set up to monitor the surface water quality in the study area. Each such sampling point represents a unique category of microenvironment.

The area under study is the basin of river Kosi which pass through Kashipur, Uttarakhand. It covers 2,367 Km² areas. The people of this area work mainly in agriculture and industries in nearest places. The Kosi River water is used for agricultural, domestic use and as well as drinking purpose.

The area under study is the basin of river Bahella which pass through Kashipur, Uttarakhand. The people of this area work mainly in agriculture and industries in nearest places. The Bahella River water is used for agricultural, domestic use and as well as drinking purpose in some places.

The area under study is the Mahadev stream which passes through villages near Kashipur, Uttarakhand. The people of this area work mainly in agriculture and industries in nearest places. The Mahadev stream water is used for agricultural and domestic use in some places.

The area under study is Khokratal which is near Kharagpur Devipura village of Kashipur, Uttarakhand. The people of this area work mainly in agriculture and industries in nearest places. The Khokratal water is used for agricultural, domestic use.

These stations were selected on the basis of even distribution over the study area taking in to consideration various factors like topography of the region, proximity of sensitive establishment and human settlements, industrial activities in the area and its proximity, down wind direction etc. Location plan of the sited ambient air quality monitoring station is presented in Figure 1 and each station site is briefly described below:

The details of the surface water sampling locations are mentioned in Table and in Figure.

**Table 9.1.1: LOCATIONS FOR SURFACE WATER SAMPLING**

| Sl.no | Code | Location | Direction | Distance |
|---|---|---|---|---|
| 1 | SW-1 | Bahella River (U/S) | NW | 2.0 |
| 2 | SW-2 | Bahella River (D/S) | SW | 2.0 |
| 3 | SW-3 | Mahadev Stream | NW | 5.0 |
| 4 | SW-4 | Kosi River (U/S) | E | 6.0 |
| 5 | SW-5 | Kosi River (D/S) | SE | 6.0 |
| 6 | SW-6 | Khokratal Lake | W | 7.0 |

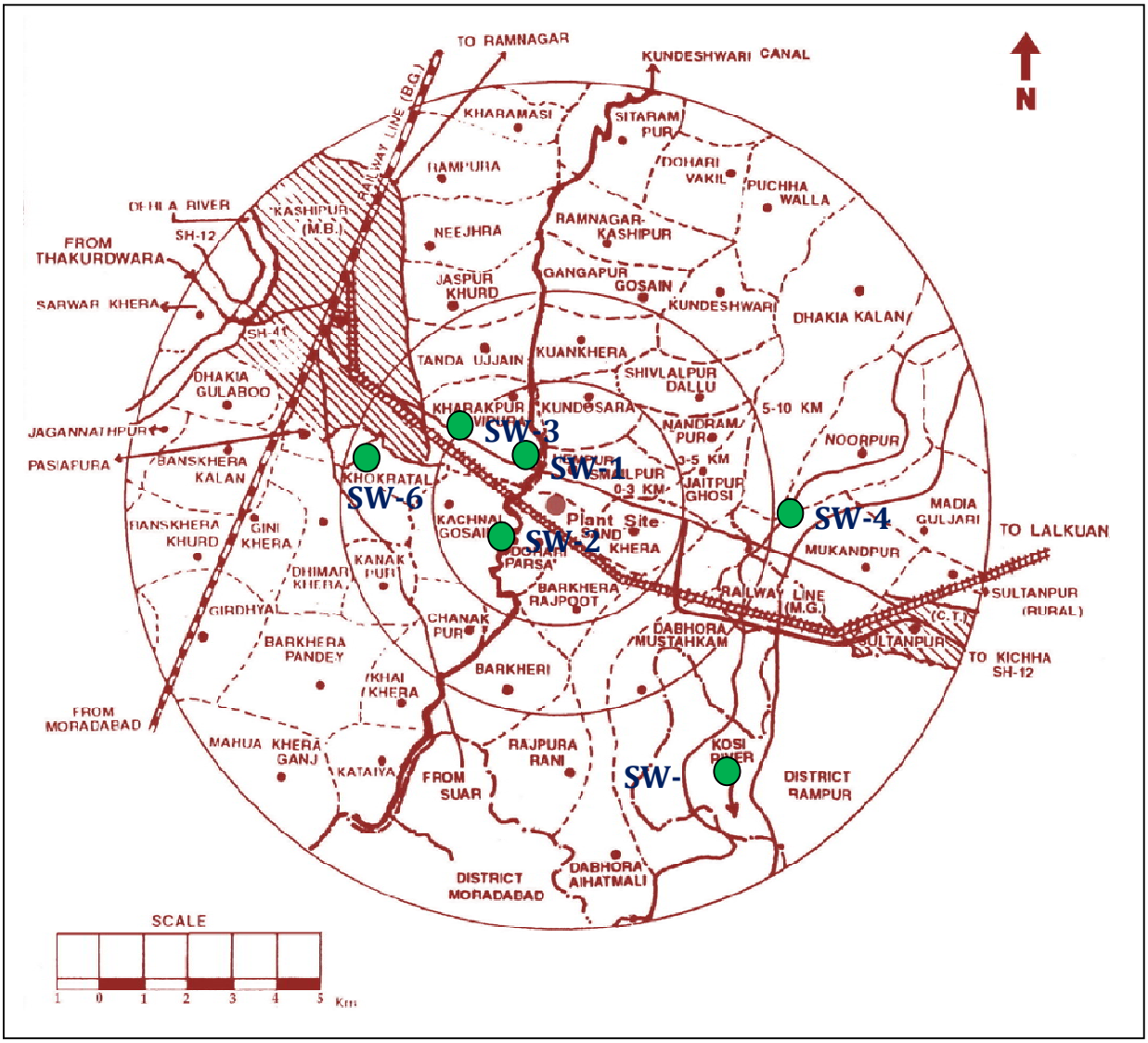



**Fig 9.1.1: LOCATIONS FOR SURFACE WATER SAMPLING**

These water samples are analyzed in laboratory as per the methods described In **IS: (3025-1964)**.

## 8.2 Result and Discussion.

Various key parameter of surface water is monitor and presented in Table 19 and Figure 24 to Figure 27 for study year 2011 as well as for other years in Table 20 to Table 30. Results are summarized below.

**Temperature**: - The maximum water temperature ($20^0$C) was obtained at station 1 and minimum water temperature ($17^0$C) was obtained at station 4. The variation in water temperature may be due to different timing of collection. Temperature controls behavioral characteristics of organisms, solubility of gases and salts in water. No other factor has so much influence on temperature .

**pH**: - The maximum value of pH of the water samples was recorded as 8.0 at station SW-2 and minimum value of pH was recorded as 7.48 at station SW-3 & SW-5. In general pH was within the limits of standard value. For drinking water source, pH range of 6.5-8.5 is recommended.

**Turbidity**:-The present study shows the turbidity in the range of 2.2 -4.8 NTU. World Health Organization prescribed the highest desirable limit 5.0 NTU and maximum permissible limit 25.0 NTU. The value of turbidity present is within permissible limits.

**Total Alkalinity**: - The alkalinity of water is its capacity to neutralize acids. The maximum alkalinity was recorded as 302 mg/l at station SW-5 and minimum value is recorded as 143 mg/l at station SW-2. BIS has set a desirable level of alkalinity in drinking water to be 200 mg/l where as its value has been prescribed to be 600 mg/l in the absence of alternative source. So in maximum stations value of total alkalinity present in water are within limit except station SW-5.

**Total hardness**: - In the present study water samples of different locations was observed in the range of 288-478 mg/l. The hardness of water is not a pollution parameter but indicates water quality.

**BOD**: - Biochemical oxygen demand is usually defined as the amount of oxygen required by bacteria in stabilizing the decomposable organic matter. BOD gives an idea about the extent of pollution. In present study water samples, sampling stations BOD was found in the range of 2-8 mg/l, it indicates that the pollution affects the water quality. As water can

be use as drinking water without conventional treatment but after disinfection if BOD 5 days 200C is 2 mg/l or less.

**COD**: - The chemical oxygen demand is a measure of oxygen equivalent to the requirement of oxidizing organic matter contents by a strong chemical agent. The COD test is helpful in indicating toxic conditions and the presence of biologically resistant organic substances. The maximum COD value was recorded 24.4 mg/l at station SW-6 and the minimum values was recorded as 8 mg/l at station SW-4. The high value of COD due to high level of pollutants present in water samples.

**DO**: - Dissolved oxygen is usually defined as the amount of oxygen available in stabilized water. DO gives an idea about the extent of pollution. In present study water samples, sampling stations DO was found in the range of 2.8-5 mg/l, it indicates that the pollution affects the water quality. As water can be use as drinking water without conventional treatment but after disinfection if DO is 6 mg/l or more.

**Chlorides**: - Chlorides occurs in all natural waters in widely varying concentrations. The chloride contents normally increases as the mineral content increases. In present study the chloride concentration were found in the range of 14-56 mg/l. The maximum chloride contents were due to addition of natural contaminants and pollutants at monitoring station SW-6 (Khokratal).

**Nitrate**: - The nitrate content of water bodies was found in the range of 16-32.5 mg/l. The highest value of 32.5 mg/l was recorded at station SW-6 (Khokratal) while minimum at station SW-1 (Bahella River U/S) and it is observed that all the station except SW-1 (Bahella River U/S) are higher the accepted limits of drinking water standards of ICMR. (Limit of Drinking water as per ICMR 20 ppm and ISI 45 ppm).

**Fluoride**: - The fluoride content in water is below detectable limit.

### 8.2.1 Statistical analysis of Environmental Parameters in Surface water of SW-4 KOSI RIVER-U/S between 1998 & 2011

**TDS at sampling point SW-4 KOSI RIVER-U/S**

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting TDS at SW4-Kosi River U/S in year 2015 will be

205.8 mg/l mg/l and in year 2020 will be 161.8 mg/l if the source of emission will be increasing similarly.(Ref. Figure 18)

**TSS at sampling point SW-4 KOSI RIVER-U/S**

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting TSS at SW4-Kosi River U/S will be 138.7 mg/l (in year 2015) and 169.4 mg/l (in year 2020) if the source of emission will be increasing similarly. (Ref. Figure 19)

**BOD (3 days at 27 deg C) at sampling point SW-4 KOSI RIVER-U/S**

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting BOD at SW4-Kosi River U/S will be 0.08 mg/l (in year 2015) if the source of emission will be increasing similarly. (Ref. Figure 20)

**COD at sampling point SW-4 KOSI RIVER-U/S**

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting COD at SW4-Kosi River U/S will be 8.81 mg/l (in year 2015) and 8.32 mg/l (in year 2020) if the source of emission will be increasing similarly. (Ref. Figure 21)

**Total Hardness as $CaCO_3$ at sampling point SW-4 KOSI RIVER-U/S**

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting Total Hardness as $CaCO_3$ at SW4-Kosi River U/S will be 208.7 mg/l (in year 2015) and 197.04 mg/l (in year 2020) if the source of emission will be increasing similarly. (Ref. Figure 21)

**Total Alkalinity as $CaCO_3$ at sampling point SW-4 KOSI RIVER-U/S**

Based on the available previous monitoring report (1998 to 2011) we have tried to extrapolate the data and expecting Total Alkalinity as $CaCO_3$ at SW4-Kosi River U/S will be 50.7 mg/l (in year 2015) if the source of emission will be increasing similarly. (Ref. Figure 23)

### 8.3 Conclusion.

Water samples collected from Kosi river, Mahadev stream, Bahela river is in all physico-chemical parameters examined. In general all the parameters are within the range of standard values prescribed by various agencies.

The water of Khokratal is found highly contaminated during the course of study and it is unfit for consumption, domestic and irrigation purposes.

# 9 STUDY OF SOIL ENVIRONMENT

## 9.1 Introduction:

Assessment of soil quality is an important aspect with reference to tree plantations, percolation of water, groundwater impact, etc. The soil quality of the study area is assessed by collecting samples at different locations. The location of soil sampling is depicted in **Table 10.2.1** & **Figure 10.2.1.**

The major sources of pollutants of Kashipur are domestic wastage due to unplanned urban development and industrial waste from the industries and mining activity without adequate attention to sewage and waste disposals.

## 9.2 Methodology:

Total of 10 different locations were identified to collect the soil sample. Each such sited station represents a unique category of microenvironment. Sampling point selected based on the criteria mentioned below:

- Zone of possible pollutant concentration.
- Area of population exposure.
- Dispersion of pollutants from other sources located outside the study area.
- Non-Industrial reference station providing background level

Sampling points were selected within the 10 Kms radius of study area . These samples were selected on the basis of even distribution over the study area taking in to consideration various factors like topography of the region, proximity of sensitive establishment and human settlements, industrial activities in the area and its proximity etc. Location plan of the sited soil quality monitoring station is presented in Figure below and each station site is briefly described below:

A-1 Industrial area is located around 7 km east of Kashipur city. Uniqueness of this sampling point is the fact that all other samples are collected within 10 km radius of this sampling point. Ginni Khera is a very small village located around 3 km of Prolific Papers (P) Limited. Uniqueness of this station is that, it is away from industries (except a paper plant) and city. The selected sampling point is considered to be agriculture land and

exhibit intense agri-business and rural activity. Nandrampur is a village located near A-1 industrial area Kashipur. Dhakia Kalan is a village located around 7 km north east of A-1 industrial area. Uniqueness of this station is it is away from industries but mining activity has been noticed near this area, thus it can give impact from dumps, mine tailings. Dabhaura Mustahkam is a village located around 3.5 km south east of India Glycols and around 2.5 and 2 km east of Chima Paper and Multiwall Paper respectively. Barkheri is a village located around 2 km west of Chima Papers and around 2 km South of A-1 industrial area. Uniqueness of this station is the fact that it is affected with pollution load of industries and unpaved road. Kharakpur Devipura is a village located around 4 km west of India Glycols Limited and in between A-1 Industrial area and Kashipur City. Uniqueness of this station is that, it is away from industries and city. The selected study station is considered to be agriculture land and exhibit intense agri-business and rural activity. Kashipur sampling point will represent the pollution load domestic sewage penetrates to ground water. Gangapur gosain is located in approximately 6 km north of A-1 Industrial area. The sampling point is considered to be agriculture land and exhibit agri-business.

**Table 10.2.1: LOCATIONS FOR SOIL SAMPLING**

| Sl.no | Code | Location | Direction | Distance |
|---|---|---|---|---|
| 1 | S-1 | On Site | - | - |
| 2 | S-2 | Ginni khera | W | 6.8 |
| 3 | S-3 | Dhakia kalan | NE | 8.5 |
| 4 | S-4 | Dhabora mustakham | SE | 5.0 |
| 5 | S-5 | Barkheri | S | 4.6 |
| 6 | S-6 | Barkera pande | SW | 6.9 |
| 7 | S-7 | Nandrampur | NE | 3.8 |
| 8 | S-8 | Kharakpur devipura | NW | 3.0 |

| Sl.no | Code | Location | Direction | Distance |
|---|---|---|---|---|
| 9 | S-9 | Kashipur | NW | 9.0 |
| 10 | S-10 | Gangapur Gosain | N | 6.0 |

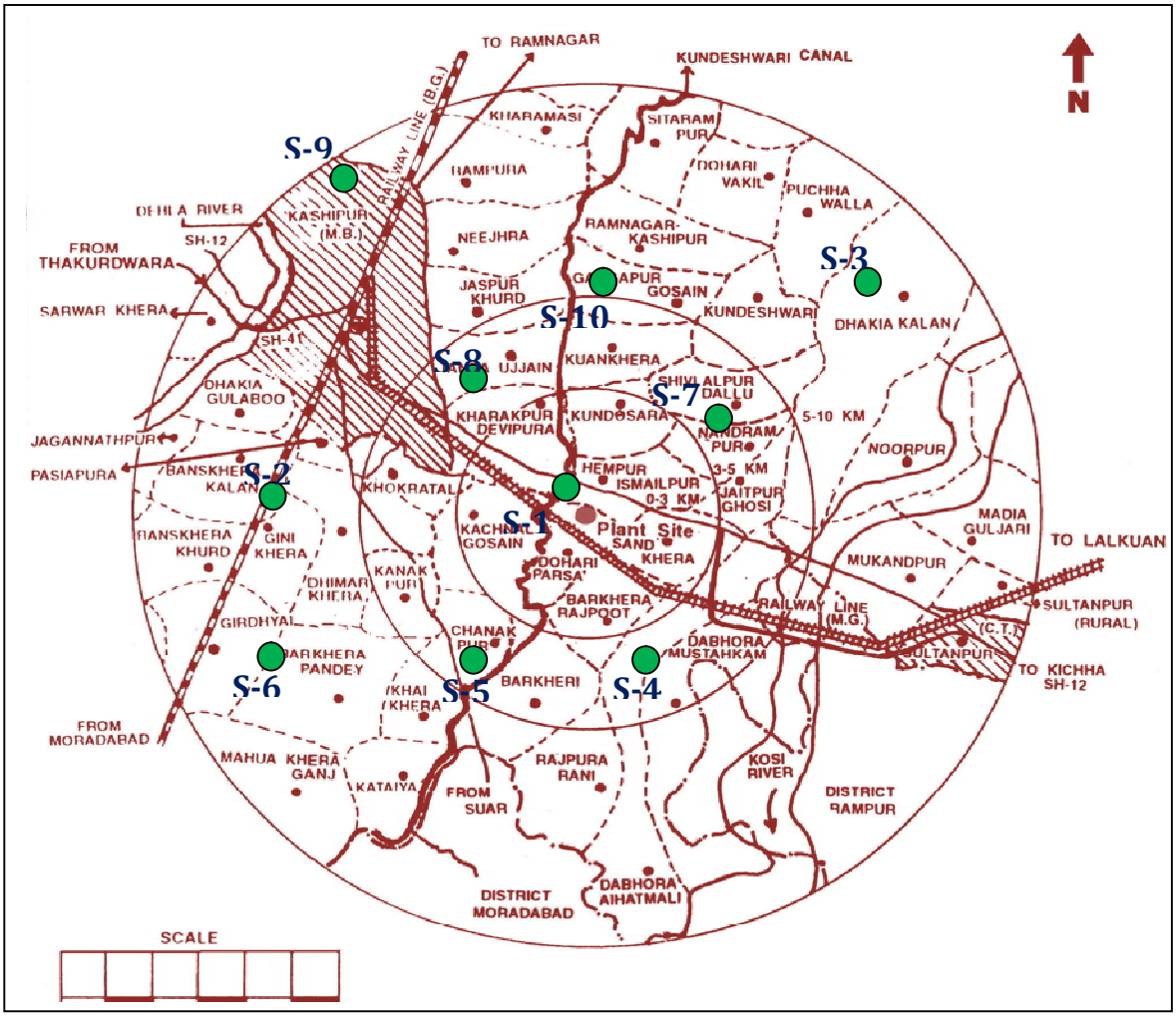



**Fig 10.2.1 LOCATIONS OF SOIL QUALITY SAMPLING STATION**

The physical and chemical characteristics of the soil of the study area are assessed by analyzing various parameters as per the methods described in "Soil Chemical Analysis" (M.L Jackson).

### 9.3 Result and Discussion:

Various key parameter of Soil quality is monitor and presented in Table 31 and Figure 28 to Figure 34 for study year 2011 as well as for other years in Table 32 to Table 36. Results are summarized below.

**pH(1:5 Aq. Extract)**: The soil at all the monitoring location was found to be slightly alkaline with pH range of 7.1 to 7.7.

**Conductivity(1:5 Aq. Extract)**: The soil at all the monitoring location was found to be in the range of 283 µS/cm to 960 µS/cm. The high value of electrical conductivity indicates the presence of appreciable amount of ions in the soil samples

**Na, K, Ca analysis**: The soil samples were found to be enriched with Na (range 3.5-6.8 mg Kg -1), K (range 68-168 mg Kg -1) and Ca (range 6.6-24.1 mg Kg -1). Sodium is the most important element, which influence the soil quality and plant growth either by affecting the permeability of soil by clogging or replacing other cat ions.

**Chloride**: Chloride was observed in range between 12.0 to 23.0 mg/kg. This distribution may because of agricultural run off.

**Sulphate**: Sulphates were observed in range between 12.2 to 26.4 mg/kg. This distribution may because of agricultural run off.

**Conclusions**

The pH of soil samples was found to be more towards basic during monitoring. Conductance value and Chlorides are low. The concentrations of sodium and potassium in soil samples represent the use of chemical fertilizers in the surrounding agrifields.

# 10 STUDY OF DEMOGRAPHIC STATUS

## 10.1 Introduction:

As of the 2001 India census, Kashipur had a population of 92,967. Males constituted 53% of the population and females 47%. Kashipur has an average literacy rate of 78%, higher than the national average of 59.5%, work participation rate is 26%. In Kashipur, 14% of the population is under 6 years of age. Languages spoken are Hindi, Punjabi, and English.

## 10.2 Demography of the study area

The prevailing status of socio-economic aspect includes the human environment of the area. This reflects the demographic characteristics and socio-economic condition of the people in the area. The proposed project will definitely have some impact on the socio-economic environment of the people of surrounding villages because of development in the study area.

As per the 2001 Census, the total population of the study area is around 1,61,990., out of which 69023 person are living in rural areas while 92967 people belongs to urban area mainly in Kashipur town.

**Urban Area**

The demographic profile of Kashipur, which is a major settlement included in 10.0 km radius study area is mentioned in Table (Urban Area Profile of Kashipur Town).

**Table 11.2.1: Urban Area Profile of Kashipur Town**

| | | | |
|---|---|---|---|
| Number of Households | 15,625 | Average Household Size(per Household) | 6.0 |
| Population-Total | 92,967 | Proportion of Urban Population (%) | 100 |
| Population-Rural | 0 | Sex Ratio | 899 |
| Population-Urban | 92967 | Sex Ratio(0-6 Year) | 908 |
| Population(0-6Years) | 13,648 | Sex Ratio (SC) | 881 |

| Table 11.2.1: Urban Area Profile of Kashipur Town | | | |
|---|---|---|---|
| SC Population | 4,860 | Sex Ratio (ST) | 897 |
| ST Population | 74 | Proportion of SC (%) | 5.0 |
| Literates | 61,981 | Proportion of ST (%) | 0.0 |
| Illiterates | 30,986 | Literacy Rate (%) | 78.0 |
| Total Workers | 24,236 | Work Participation Rate (%) | 26.0 |
| Main Worker | 22,156 | % of Main Workers | 24.0 |
| Marginal Worker | 2,080 | % of Marginal Worker | 2.0 |
| Non Worker | 68,731 | % of non Workers | 74.0 |

**Rural Area**

The demographic profile of rural areas including 44 villages in 10.0 km radius study area is mentioned in Table below.

| Table 11.2.2: Rural Area Profile of villages covering under 10.0 km study area | | | |
|---|---|---|---|
| Number of Households | 11551 | Average Household Size(per Household) | 6.0 |
| Population-Total | 69023 | Proportion of Urban Population (%) | 0.0 |
| Population-Rural | 69023 | Sex Ratio | 891 |
| Population-Urban | 0 | Sex Ratio(0-6 Year) | 900 |
| Population(0-6Years) | 12929 | Sex Ratio (SC) | 879 |
| SC Population | 18998 | Sex Ratio (ST) | 1004 |
| ST Population | 2489 | Proportion of SC (%) | 27.5 |
| Literates | 35592 | Proportion of ST (%) | 3.60 |
| Illiterates | 33431 | Literacy Rate (%) | 64.45 |
| Total Workers | 19611 | Work Participation Rate (%) | 28.4 |

**Table 11.2.2: Rural Area Profile of villages covering under 10.0 km study area**

| | | | |
|---|---|---|---|
| Main Worker | 15264 | % of Main Workers | 22.1 |
| Marginal Worker | 4347 | % of Marginal Worker | 6.3 |
| Non Worker | 49412 | % of non Workers | 71.6 |

The over all demographic details of the study area are listed in **Tables** including:

- Population Distribution
- Socio-economic Status
- Basic Amenities & Infrastructure
- Agricultural Land Distribution

**PLACES OF TOURISM INTEREST**

***Drona Sagar Lake***

Drona Sagar is believed to be associated with Guru Dronacharya, teacher of the Pandavas and the Kauravas in the epic Mahabhrata. Many believe that the Drona Sagar was created by the Pandavas as a Guru Dakshina (fee) for Dronacharya. The Skand Purana states that the water of Drona Sagar is as holy as that of the Ganges.

At present a huge pond with lotus flowers is situated here. The pond is surrounded by temples of various deities. Earlier, there were 32 temples around the periphery of this pond. The excavated site at Drona Sagar is protected by the Archaeological Survey of India.

***Shree Bheema Shankar (Moteshwar) Mahadev***

Shree Moteshwar Mahadev also known as Shree Bheem Shankar Mahadev is an abobe of Lord Shiva in Kashipur, this place was known as the Dakini State in ancient days Shree Bheema Shankar (Moteshwar) Mahadev is also considered as one of the 12 Jyotirlinga of Lord Shiva.

***Maa Bal Sundari Mandir***

Bal Sundari Mandir also known as Chaiti Mandir, is the most famous temple in Kashipur. During Navratras in March a grand fair is held here every year. The fair draws thousands of pilgrims and devotees from far-flung areas. Devotees throng the temple to offer their prayers to the revered Goddess.

***Gurdwara Sri Nankana Sahib***

Gurdwara Sri Nankana Sahib is located in the city of Kashipur, in Mohalla Pakka Kot, near Nagnath Mandir.

The study area contains a number of places having Historical & Archeological importance with prospects of tourism.

The Jim Corbett National Park lies out side the study area adjacent to Ramnagar Town & is about 25.0 km away North-West from the proposed plant site. The famous Hill station of Nainital lies about 80.0 km North-East of the A-1 Industrial Area.

**EDUCATION**

Kashipur is fast growing city in Uttarakhand where industries have sprung up at a great pace. The city is in developing stage in terms of education.

*ITI Kashipur* is regarded one of the best ITI's in Uttarakhand and provides only Diploma Courses.

*Government Polytechnic Kahsipur* is providing great engineers for the country. It is the biggest and oldest polytechnic in Uttarakhand.

The *Indian Institute of Management (IIM)* is setting up a new campus in Kashipur which will give this city a new direction in the field of education. Approximately 200 Acres of Land in the Escorts Farm area of Kashipur, Uttarakhand have been allocated by the Government of Uttarakhand for the Institute. IIM Kashipur has started it academic activities from July, 2011,

**INDUSTRIAL ACTIVITIES**

Kashipur is emerging as an important Industrial Centre of Uttarakhand. Central Government announced several benefits. With a government eager to promote trade and industry by providing extensive benefits and incentives, Kashipur has become the new

industrial hub in India. With Kashipur fast becoming a thriving industrial center, the city is ideally suited for Industrial Park projects with cost of living compared to metros. "Mahuakhera Ganj" is a newly developing industrial area in this town.

Prominent existing units are:

1. Cheema Papers Board Ltd.
2. Multiwall Pulp & Board Pvt. Ltd.
3. Kashi Vishwanath Steels (KVS) Ltd.
4. DSM Sugar (kashipur) Ltd.
5. Satnam Paper Mills Pvt. Ltd.
6. Goraya Straw Board Mills Pvt. Ltd.
7. Jindal Solvant Extraction
8. Banwari Paper Mills Ltd.
9. Prakash Industries
10. Salora International Ltd.
11. Surya Roshni Ltd.
12. Techno Electronics (A Videocon Group Company).
13. Shri Shyam Pulp & Paper Mills
14. Nani Paper Mills
15. SRF Ltd.
16. U.P.State Textile Corporation
17. Essar Fastners Pvt. Ltd.
18. Vinayaka Engineering Industries
19. Vishwakarma Paper Mills Ltd.
20. Sidderath Paper Mills Ltd.
21. Katyayini Paper Mills Pvt Ltd

22. Sravanthi Energy Pvt. Ltd

23. Gama Infraprop Pvt. Ltd

**INFRASTRUCTURE STATUS:**

a) Education Facilities: Most of the villages in the study area have primary education facility, while secondary education is available in 50% villages. Higher education like Graduation & Post Graduation is available only in kashipur. Other technical institute like ITI, Government Polytechnic, IMT are also available in Kashipur town.

b) Medical Facilities: Medical facilities in the study area are very poor. Among all the villages there are only 03 Hospitals, 02 Nursing Home & 04 Primary Heath Centre. Three of the villages in the study area have Maternity Home.

c) Drinking Water: Main source of water in the study area is hand pump and during study we have found that around 22 villages have tap water supply also.

d) Post & Telegraph Facilities: Almost all villages in the study area have telephone connection except three villages. A total of 344 telephone connections has been provided.

e) Banking Facilities: The main harbor where baking facilities is available is kashipur, but as per the concern of villages, there are only two villages have commercial bank.

f) Credit Societies: There is no any credit society in rural area but nears town kashipur has a number of agricultural as well as non-agricultural credit societies.

g) Recreational Facilities: The rural areas in the study area neither have any cinema hall nor any sport stadium. The nearest place to provide recreational facility is Kashipur.

h) Marketing Facilities: These facilities are available only in town of the study area. Generally all the villages in the study area have one or two small shops or kirana store or general repairing shops. Kashipur is the main & nearest town have all infrastructural facilities & an important commercial center of the area.

i) Transportation & Approach to Village: As is evident from census data about 90% villages can be approached by *Pucca* Road while the remaining are linked by Mud Road or Footpath. The area is well connected mainly with road transport but rail facility is available only in Kashipur town.

j) Power Supply: In the study area all the villages are electrified for all purposes i.e. domestic, agricultural & industrial activity.

k) Agricultural Status: As per the survey data primary economic activities in study area are agricultural. Paddy, Sugarcane Maize Wheat, Sarson, Potato Peas & Pulses are common seasonal crops. Sugarcane & Potato are common cash crops of the area. Irrigation facilities are good in the area.

# 11 PREDICTION ON ENVIRONMENTAL IMPACT

## 11.1 Introduction

Impact assessment describes identification and appraisal of various impacts due to the ongoing activities/projects.

"Environmental Impact" can be defined as any alteration of environmental conditions or creation of a new set of environmental conditions, adverse or beneficial, caused or induced by the action or set of actions under consideration.

**CONSTRUCTION PHASES**

The construction and operational phase of the project activity comprises various activities each of which may have an impact on environmental parameters. Various impacts during the construction and operation phase on the environment have been studied to estimate the impact on the environmental attributes and are discussed in the subsequent section.

## 11.2 Impact During Construction Phase

The impact during construction will be localized and short term with permanent changes in use of surrounding land as compared to the current conditions. Impact will be primarily related to the civil works and less intensive impact is expected during erection of the equipment and trial operation. The environment impact matrix illustrates the impact of each activity during construction on the specific environment parameters.

The environment impact matrix for the construction phase is shown in Table 12.2.1 given below

**Table 12.2.1: ENVIRONMENT IMPACT MATRIX FOR THE CONSTRUCTION PHASE**

| | Environmental Attribute | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Activities** | Air | Noise | Hydrology | Land & soil | Climate | Ecology | Socio Economics | Aesthetics |
| Site Clearing | ✓ | ✓ | | ✓ | | | ✓ | |

| Activities | Environmental Attribute | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Air | Noise | Hydrology | Land & soil | Climate | Ecology | Socio Economics | Aesthetics |
| Civil Construction work | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Material Storage & Handling | ✓ | ✓ | ✓ | | | | ✓ | |
| Water Supply | ✓ | | ✓ | | | | | |
| Mechanical & Electrical erection | ✓ | ✓ | | | | | ✓ | |
| Transport | ✓ | ✓ | | ✓ | | | ✓ | |
| Accommodation of Labour | | | | | | | ✓ | ✓ |

### 11.2.1 Impact on Topography and Land-use

Prior to construction, land is developed through leveling and grading.

The construction activities attract a sizeable population and influx of population. The engaged population is arranged from nearby contractors and only allowed for working day hours, that means there would be no any association with construction of temporary hutments for construction work force, having an effect on land use pattern of the areas surrounding the project.

### 11.2.2 Impact on Soil Environment

Site preparation activities (like site clearing and leveling, excavation, earth movement) and construction activities would result into permanent loss of topsoil of the construction area. These impacts are envisaged to be minor because of the following reasons:

- It shall be confined to the construction areas.
- Removed topsoil may be utilized for landscaping and land improvement in other areas, which are not under construction.

### 11.2.3 Impact on Air Environment

During construction phase, suspended particulate matter will be the main pollutant, which will be generated due to the site development activities and vehicular movement, because

of vehicular traffic there may be a marginal increase in the concentrations of NOx and $SO_2$.

The impact of such activities would be temporary and restricted to the construction phase only. Proper upkeep and maintenance of vehicles, sprinkling of water on roads at construction site, providing sufficient vegetation etc. are some of the proposed measures that would greatly reduce the impact on the air quality during the construction phase of the project. The impact of such activities would be temporary and restricted to the construction phase only and will be confined within the project premises.

### 11.2.4 Impact on Noise Environment

The study area is likely to experience a marginal increase in ambient noise level due to the constructional activity, the traffic for loading and unloading, fabrication and handling of equipment and materials, construction equipment like dozer, scrapers, concrete mixer, crane, generators pumps, and compressor, Pneumatic tools, vibrators, etc. During the construction phase these equipment will generate noise ranging between 55-70 dB (A). The affected areas will be those which are closer to the site.

To minimize the impact on nearby communities, construction schedules would be optimized to daytime working and the night activities will be scaled down. Extensive earthmoving and movement of heavy equipment would be conducted only during the regular working hours in day time. The mitigation measures for protection of the workers from exposure of the noise generating devices is adopted as follows.

- Locating of noise generating equipment as far as possible away from the working area.
- Fitting mufflers to road vehicles and construction equipment.

Adequate personal protective equipment like ear plugs and ear muffs shall be provided to the plant workers to reduce the effect of noise.

Overall, the impact of generated noise on the environment during construction period is likely to be insignificant, reversible and localized in nature and mainly confined to the day hours. The noise level will only drop down to the acceptable level, once construction period will be over.

### 11.2.5 Impact on Water Quality

The water requirement for the proposed installation will be sourced from existing bore well / water sources. The local labor force will be deployed during construction phase and no colony would be proposed as the workers will be employed from the nearby local village. Minor impact is envisaged on ground water source during construction phase, which will be temporary. However necessary permission will be taken from the concerned authority. The sewage water generated during construction at site will be disposed into septic tank. Hence the effect on the water body is minimal.

### 11.2.6 Impact on Ecosystem

- **Terrestrial Ecosystem**

The land of study is a plain area and there is no any sloping side. The area to be situated for is not having any flora and fauna. Thus the impact on terrestrial ecosystem during construction phase may be found significant or in-significant.

- **Aquatic Ecosystem**

There will not be any discharge of wastewater outside the premises or any nearby water bodies. The sewage generated during construction will be disposed into septic tank. Hence, there will not be any impact on aquatic ecosystem of the study area.

### 11.2.7 Impact on Social Environment

The projects will provide either direct or indirect job opportunities to the local population as far as possible. There will be some migration of skilled labor force from outside the study area during construction phase, which may put some pressure on the local settlements and resources.

Considering the size and nearby industrial activities envisaged the immigration of work force for construction phase (including contractor labors) would have marginal impact on demography (*e.g.* changes in total population, sex ratio, literacy level, main workers *etc.*) of the immediate vicinity area. In addition, the socio-economic status of the area may improve due to flow of men, material and money.

Infrastructure facilities such as sanitation, fuel, restroom, medical facilities, safety etc. during construction phase are required to be provided for the labor force during

construction as well as to the casual workers including truck drivers during operation phase.

The positive impacts of these may lead to the following:

- Increase in employment opportunity to non-workers in the study area as non-skilled and semi-skilled workers.
- Growth of services (like retail shops, automobile workshops, etc.) and increase in employment and trade opportunities in service sector.
- Increase in per capita income and overall economic upliftment of the area and improvement in transport, communication, health and educational services.

The negative impacts could be summarized as follows:

- Strain on civic amenities (like road, transport, communication, water supply and sanitation, health care and recreational utilities etc.) due to increase in floating population.
- Increase in consumer prices of indigenous services and produces like egg, fish, vegetables, fruits, milk, etc.

It is difficult to assess the above impacts quantitatively on a measurable scale. However, most of these impacts will be short term and limited to the construction period only. The increase in employment opportunities (project and service sector) and overall economic upliftment of the area is certain to happen.

### 11.2.8 Traffic Congestion

Traffic volume on nearby roads will take place due to movement of heavy vehicles (HEMMs) during the construction phase, which may cause public inconvenience.

A traffic management plan for the area will be developed to ease the situation. The following arrangement would be made to ease the situation.

- Drivers of trucks / dumpers engaged in construction work will be instructed to give way to passenger buses, cars etc. to avoid inconvenience to public transport system.

- Transport of construction materials and machineries shall be carried out during lean traffic period of the day or during night.

### 11.3 Impact During Operation Phase

The impact during the operation phase will be continuous in nature. However whatever impact on environment is present will be minimized through incorporation of efficient technologies for pollution control measures.

The environment impact matrix for the operation phase is shown in **Table 12.3.1 below**

**Table 12.3.1: ENVIRONMENT IMPACT MATRIX FOR THE OPERATION PHASE**

| | Environmental Attribute | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Activities** | Air | Noise | Hydrology | Land & soil | Climate | Ecology | Socio Economics | Aesthetics |
| Plant Operations | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | |
| Raw Material Storage & Handling | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Mechanical & Electrical erection | ✓ | ✓ | ✓ | | | | ✓ | |
| Water Supply | ✓ | ✓ | ✓ | | | | | |
| Solid Waste | ✓ | ✓ | ✓ | ✓ | | | ✓ | |
| Transport | ✓ | ✓ | | ✓ | | | ✓ | |
| Working Staff | | ✓ | | | | | ✓ | ✓ |

#### 11.3.1 Impact on Topography and Land-use

At the end of construction phase, the modified land-use pattern would gradually stabilize during the operation phase. The proposed industrial activity involves setting up of additional major structures within the proposed site areas.

There will be minor changes in the topographical features. The project proponents will undertake tree plantation, planning of waste disposal. This will have beneficial impact on the overall landscape.

### 11.3.2 Impact on Climate

The plant proponents will undertake greenbelt development activities, which will have moderation effect on the climate in the vicinity.

### 11.3.3 Impact on Soil Environment

The top soil released from Site preparation activities (like site clearing and leveling, excavation, earth movement) and construction activities would be utilized for additional plantations for landscaping and land improvement in other areas, which are not under construction.

### 11.3.4 Impact on Air Quality

Load of $SO_2$, NOx, hydrocarbons, flue gases etc. on air environment would be addressed appropriately.

Emission of particulate matter will be expected to generate from handling & processing of raw material , which will be controlled by sprinkling of water on affected area. Further, green belt will strengthen to reduce the effect of minor pollutants.

### 11.3.5 Impact on Ground Water Quality

The water requirement for the proposed installation will be sourced from existing water sources. The water will be drawn and stored in a reservoir tank and OHT and pumped.

### 11.3.6 Impact on Noise Levels

During the operational phase, noise will be generated from the machines, pumps, compressors, vehicles movement, and general noise characteristic of a proposed industry. The objectionable noise generating machines will be isolated from the outside environment and proper arrangements will be made to control the noise generated from the plant.

### 11.3.7 Impact on Ecological Environment

- **Terrestrial Ecology**

The development of greenbelt covering all around the industrial activities will contribute positive impact towards improved soil stabilization, prevention of top soil erosion, increased vegetative cover, density and diversity of flora etc. Also it will improve the aesthetic look of the surrounding area.

- **Aquatic Ecology**

The aquatic biological environment in the vicinity of the proposed project will be studied and there will be no untreated discharge form the projects. Hence, there will be no severe impact on aquatic ecosystem due to operation of the project.

### 11.3.8 Impact on Traffic and Transport

Minor impact on traffic and transport system is envisaged due to the transportation of raw material.

### 11.3.9 Health

No adverse impact on the health status of the local people is envisaged as the projects will be based on the clean process technology & there is no source of air pollutant emission; so, there will be no impact on $SO_2$ and NOx level, also the particulate matter will be well within prescribed standards.

Medical facilities will also be developed in the area under corporate social responsibility, which will help in availing treatment in the locality.

### 11.3.10 Employment

After the setting up of the plants, there is going to be generation of employment in the secondary sectors which will provide employment to the local population. During operation phase indirect job opportunities will be created in the plant and in petty business outside the project boundary. The project will improve the basic infrastructure. The proposed long-term activity will open up market and opportunities for self employment.

# 12 ENVIRONMENTAL MANAGEMENT PLAN

Environmental Impact Assessment (EIA) is the process used to integrate environmental management with planning for proposals. EIA is an established process for:

- Identifying potential environmental impacts;
- Recommending mitigation measures for the negative impacts;
- Identifying opportunities for enhancement measures;
- Providing an effective framework for operating Environment Management System and other functions of the project by assigning roles and responsibilities for environmental monitoring and management;
- Formulating Environmental Action Plans (EAPs) which specify mitigation, periodic and annual monitoring activities during project implementation and operation.

Industrial development is an important constituent in our pursuits for economic growth, employment generation and betterment in the quality of life. On the other hand, industrial activities, without proper precautionary measures for environmental protection are known to cause pollution and associated problems. Hence, it is necessary to comply with the regulatory norms for prevention and control of pollution. Alongside, it is also imperative to go beyond compliance through adoption of clean technologies and improvement in management practices. Commitment and voluntary initiatives of industry for responsible care of the environment will help in building a partnership for pollution control.

Preparation of Environmental Management Plan (EMP) is required for formulation, implementation and monitoring of environmental protection measures during and after commissioning of the Plant project. This Environmental Management Plan indicate the details as to how various measures have been or are proposed to be taken. The base line settings of different relevant environmental components in the study area and predicted potential impacts on those components due to the proposed project are documented. In this plan, mitigation measures for the identified environmental impacts are documented for both construction and operational stages of the proposed project in the form of an Environmental Management Plan (EMP).

## 12.1 ENVIRONMENTAL MANAGEMENT DURING CONSTRUCTION

1. During excavation and transportation on roads at the site, there is a scope for local fugitive dust emissions. Frequent water sprinkling in the vicinity of the construction activity will be done.
2. There is a likelihood of fugitive dust from the construction activity and material handling from the truck movements. The industry will take up tree plantation program around the plant site.
3. It will be ensured that those construction vehicles are properly maintained. The vehicle maintenance area will be located in such a manner, so as to prevent contamination of water sources by accidental spillage of oil.
4. Location will be identified for the storage of such flammable liquids, away from sensitive & working area. The storage will be as per institutional safety standards.
5. The construction workers will be provided with sufficient and suitable toilet facilities to allow proper standards of hygiene.
6. Onsite workers using high noise equipment will adopt noise protection devices. Noise prone activities will be restricted to daytime hours only.
7. After completion of construction activities, the rubbish will be cleared and disposed to nearby authorized sites.

**EMP FOR CONSTRUCTION PHASE IMPACTS**

| Environmental Impacts | Mitigation |
|---|---|
| **a. SITE CLEARING** | |

| | |
|---|---|
| **1.** Soil erosion | • Extent of vegetation removal shall be minimized to prevent extent of soil erosion.<br>• Vegetative cover shall be re-projected /rehabilitated at the earliest practicable time to minimize duration & extent of soil erosion. |
| **2.** Noise generation | • Selection of equipment with less noise generation to be used.<br>• The earth moving equipment shall be periodically checked and maintained for noise levels.<br>• The workers shall be provided with adequate PPE such as earplugs to reduce impact of high noise levels |
| **3.** Dust generation | • The site cleared shall be periodically watered to reduce emission of dust particles.<br>• The workers shall be provided with PPE such as dust masks and goggles to reduce impact on health. |
| **b. TRANSPORTATION OF CONSTRUCTION MATERIALS** | |
| **1.** Noise generation | • Periodic maintenance of vehicles is required |

| | |
|---|---|
| **2.** Dust generation | • Construction materials shall be covered with tarpaulin sheets to prevent the material from being air borne.<br>• The vehicle speed shall be regulated.<br>• The workers transporting materials shall be provided with PPE such as dust masks to reduce impact of air borne dust on their health |
| **3.** Vehicular emissions | • Periodic emission check for vehicles is required.<br>• Clean fuel shall be used for vehicles. |
| **c. CONSTRUCTION ACTIVITIES** | |
| **1.** Noise generation | • Personnel Protective Equipment (PPE) such as ear plugs and helmets shall be provided for construction workers.<br>• The working hours shall be imposed on construction workers. |
| **2.** Dust generation | • PPE in the form of dust masks shall be provided for construction workers.<br>• |
| **3.** Air Emissions from construction machinery | • Periodic check and regular maintenance of construction machinery for emissions<br>• Clean fuel shall be used in equipment |

### 12.1.1 Water Resources and Quality

Following mitigation measures will be adopted to avoid impact on water resources

- Construction equipment requiring minimum water for cooling and operation for optimum effectiveness shall be chosen.
- High pressure hose will be used for cleaning and dust suppression purposes.
- Water harvesting measures would be taken.
- Appropriate sanitation facilities, septic tank and soak pits will be provided for the workers onsite and offsite to reduce impact on water resources. Regular maintenance will be done during the entire life cycle.
- No discharge of construction wastes to surface water bodies or ground water will be allowed during construction.
- Efforts will be made for reuse of water and its conservation.

### 12.1.2 Air Quality

During Construction period, there is likely hood of generation of dust and NOx emission. This can be attributed to leveling activity and vehicular movement. The transport vehicles using petrol or diesel will be properly maintained to minimize smoke in the exhaust. Since, there is likelihood of fugitive dust from the construction activity, water sprinkling will be done. In addition to this following measures will be taken during the construction phase to reduce the impact on the air quality.

- Any vehicle not meeting the vehicular pollution standards will not be allowed within the construction activity.
- Water will be sprayed by high-pressure water hoses during dust generating construction activities e.g. excavation, crushing/demolishing, concrete mixing, material handling etc. to suppress dust.
- Vehicles delivering loose and fine materials like sand and fine aggregates shall be covered by tarpaulin to reduce spills on roads.
- The height from which excavated materials are dropped shall be controlled to a minimum practical height to limit fugitive dust generation from unloading.

- The random Ambient Air Quality Monitoring shall be done to ensure that the significant impacts are being mitigated adequately.

### 12.1.3 Noise Level

The noise impact on the surrounding population during the construction phase will be within the acceptable limits. High noise generation equipment, if used will be operated during the daytime only and completely restricted during night hours and this eliminates any possible discomfort to the nearby communities.

The following recommendations will be implemented:

- Provision of insulating caps and mufflers at the exit of noise source on the machinery;
- Construction equipment generating minimum noise and vibration be chosen:
- To use of damping materials such as thin rubber / lead sheet for wrapping the work places line compressors, generators sets.
- Shock absorbing techniques will be adopted to reduce impact;
- Inlet and outlet mufflers will be provided which are easy to design;
- Ear muffs will be provided to the workers and it will be enforced to be used by the workers;
- Greenbelt will be developed along the periphery of the proposed site.
- Ambient Noise Level Monitoring shall be conducted at suitable location at periodic intervals during construction phase to conform to the stipulated standards both during day and night time.

### 12.1.4 Site Security

Adequate security arrangement will be made to ensure that the local inhabitants and the working personals are not exposed to the potentials hazards of construction activities.

### 12.1.5 Traffic Pattern

Heavy vehicular movement will be restricted to daytime only and adequate parking facility will be provided.

### 12.1.6 Solid Waste Generation

The solid waste generated during the construction phase is usually excavated earth material and Construction debris.

- Excavated earth material will be reused for backfilling between foundations to fill up the low-lying areas and whereas, topsoil will be reused for Landscaping/Greenbelt development purpose.
- Construction debris as far as possible will be reused / recycled for back filling / sub base work for roads & pavements and excess will be transported to nearby authorized disposal sites

### 12.1.7 Ecological Aspects

- Plantation of dust absorbing trees and shrubs near the dust generating areas.
- Plantation of soil binding plants e.g. grasses will be carried out to avoid soil erosion.
- Plantation of noise attenuating species to reduce noise pollution both during the construction as well as in the operation stage.
- Stabilization of all disturbed slopes before the onset of monsoon to avoid soil erosion.
- Cutting of existing trees/bushes/ other vegetation will be avoided as far as possible or will be minimized.
- Operation of high noise producing equipment will be avoided during night time to avoid impact on the immediate vicinity of the project sites surroundings.
- Use of best available construction technology to minimize impacts on flora and fauna of the project site areas.

### 12.1.8 Aesthetic aspects

- Existing aesthetics of the site will be tried to maintain by taking appropriate measures in different activities.
- Peaceful environment will be maintained in the vicinity of the project site.

- The excavated material dump will not be permitted to become a major visual feature of the local landscape. The height of the dump will not exceed the mature tree top level in the area.

### 12.1.9 Socio –Economic Aspects

- Local people from nearby Village will be employed for construction work to the maximum extent possible.
- Proper facilities for domestic water supply and sanitation services will be made available to the construction workers at the site.

## 12.2 ENVIRONMENTAL MANAGEMENT DURING OPERATION STAGE (DISTILLERY)

### 12.2.1 Air environment:

Since steam requirement to produce Ethanol is met from boiler, hence, load of $SO_2$, NOx, hydrocarbons, flue gases etc. on air environment would be expected.

Minor emission of particulate matter will be expected to generate from handling & processing of raw material, which will be controlled by sprinkling of water on affected area. Green belt of the industrial area is adequate to reduce the effect of pollutants.

### 12.2.2 Water Environment

Spent wash treatment can be possible from different routes viz;

- Compost making with press mud/agricultural residue/ Municipal Waste.
- Concentration and drying/ Incineration.
- Treatment of spent wash through bio-methanation followed by two stage secondary treatment and dilution of the treated effluent with process water for irrigation as per norms prescribed by CPCB/MoEF.

The water requirement to produce Ethanol is sourced from existing bore well/water sources. The water is drawn and stored in a reservoir tank and OHT and pumped. In the unlikely event of a power failure an overhead tank of sufficient height & capacity has been provided to ensure non–stop supply as continuous water flow is as must to cool the system.

The water softener is provided to avoid scaling in the pipelines, which will reduce the efficiency of the whole system. Requisite heat exchanges & cooling towers are provided to cool the water. As per the wastewater concern, wash water is expected to generate from the processing of raw material, which is treated through effluent treatment plant (ETP) of distillery. So, no adverse impact on groundwater is anticipated.

#### 12.2.2.1 Conventional approach of distillery effluent treatment:

#### 12.2.2.1.1 Effluent Treatment Scheme Through Anaerobic /Aerobic Treatment:

The Effluent Treatment plant design is for the Ultimate Capacity of distillery. The ETP was constructed in two stages (i.e. primary treatment for first stage and secondary treatment for second stage).

Spent wash is treated based on Anaerobic Digestion principles for Primary Treatment and Aerobic Treatment as Secondary Treatment. After Secondary Treatment the treated wastewater is subjected to Reverse Osmosis & Multi-Effect Evaporation Process. Final sludge is being treated through bio-composting process. The overall objective is to achieve "***Zero Discharge"***. The Guidelines of CPCB for the design of Bio-methanation Plant, "Composting Process" is being followed.

#### 12.2.2.1.2 Primary Anaerobic Treatment Plant (Biogas Generation Unit )

Anaerobic treatment of organic waste is a biological process in which organic matter breakdown into smaller organic and inorganic compounds. In this process acidogenic and methanogenic micro- organism feed upon organic matter under different environmental condition, as a result of which composite mixture of methane, Carbon dioxide and hydrogen sulfide is evolved. This gas is commonly termed as biogas.

Spent wash from distillery is treated an aerobically to recover methane rich biogas, which is a composite mixture of methane, $CO_2$ and $H_2S$. Spent wash is concentrated with organic and inorganic matter. It is also rich in plant nutrients such as potash and phosphate. Carbonaceous matter may be used as a source of energy or in the production of bio-manure. The treatment scheme adopted for spent wash is to achieve zero discharge and to recover the valuable products present in it for sustainable development.

#### 12.2.2.1.2.1 Biological Conditioning and Control Reactor (BCCR) & Methane Upflow Reactor (MUR)

Anaerobic treatment of organic waste is processed in BCCR followed by MUR for biological process of organic matter breakdown into smaller compounds.

First phase of the Biochemical reaction of anaerobic process is being carried out in BCCR. Here, organic compounds are solubilized, hydrolyzed and converted in to organic acids, namely Volatile Fatty Acids (Formic, Acetic, Butyric Lactic Acids, etc., with the help of Acidogenic micro-organisms. The reactor is designed in a manner to provide all the optimum process conditions for the microbiological acidification.

**Process Parameters**

| | | |
|---|---|---|
| pH | - | 5.0 - 5.5 |
| Temperature | - | 40 - 42 $^{o}$C |
| COD reduction | - | 10 - 12 % |
| Retention time | - | 2.94 Days |

All the intermediates produced during the solublisation, hydrolysis and acidification stage in BCCR are converted to methane and carbon dioxide during the methanogenesis process in MUR most of the methane comes always from MUR.

**Process Parameters**

| | | |
|---|---|---|
| pH | - | 7.0 - 7.5 |
| Temperature | - | 35 - 38 $^{o}$C |
| BOD Reduction | - | 90% |
| COD reduction | - | 70% |
| Retention time | - | 16.99 Days |

**12.2.2.1.2.2SMAT Reactor**

SMAT reactor is the heart of system and all other equipment is peripheral. Specially designed plastic media is packed in this tank. The main purpose of the media is to provide large surface area for accumulation of bio film. Acidifying as well as methanogens is immobilized on the media that allows them to be retained in the reactor indefinitely. The plastic media used is inert and resistant to acids, alkalis and also it can't

be attacked by bacteria or fungi. The media is designed in such a way to provide a very large surface area for the bacterial film to grow and immobilize. This media has voids ratio of about 95% and has specific surface of about 105 $m^2/m^3$

**Process Parameters**

| | | |
|---|---|---|
| pH | - | 7.0 - 7.5 |
| Temperature | - | 35 - 38 $^0$C |
| BOD Reduction | - | 90 % |
| COD Reduction | - | 65 - 70 % |
| Retention Time | - | 14.75 days |

**12.2.2.1.2.3 Thermophillic Reactor**

Since the process is to be operated in Thermophillic range, waste water temperature of digester feed is kept to be about 70 – 75 $^o$C. A plate type heat exchanger is provided to cool the spent wash and maintain the reactor temperature up to 50 - 55 $^0$C for providing Thermophillic condition.

**Process Parameters**

| | | |
|---|---|---|
| pH | - | 7.0 - 7.5 |
| Temperature | - | 53 - 56 $^o$C |
| BOD Reduction | - | 92% |
| COD reduction | - | 72% |
| Retention time | - | 14.06 Days |

**12.2.2.1.3 Secondary Aerobic Process**

The secondary treatment plant is designed to treat the remaining BOD after primary treatment plant by providing aerobic conditions. For providing aerobic conditions 30 aerators are provided in the lagoons. This aeration process is two-stage aeration system. The primary treated waste water which contains about 4000 to 4200 ppm BOD is treated in secondary treatment plant for further reduction of BOD.

**12.2.2.1.3.1 Pre-Aeration Tank**

The primary treated effluent from PPS first transferred to pre-aeration tank, where aerator has been provided to pre-aerate the effluent. This will help in escaping the anaerobic gases coming along with the effluent and making anaerobic sludge heavy. Thereafter, the effluent is sent to primary clarifier for removing the sludge

**12.2.2.1.3.2 Clarifier – I (Primary Clarifier)**

This clarifier is provided to separate out sludge coming along with the effluent after pre-aeration tank. The separated sludge is sent to decanter centrifuge for drying and disposal. The overflow from this clarifier is sent to CAT for further treatment

**Process Parameters**

| | | |
|---|---|---|
| Side Water Depth (SWD) | - | 3.0 meter |
| Type | - | Centrally driven |
| COD Reduction | - | 10 % |

**12.2.2.1.3.3 First Stage Aeration (CAT)**

**12.2.2.1.3.3.1 Aeration Lagoon I & II (Conventional Aeration Lagoon)**

This consists of aeration lagoons. Lagoon is having fixed aerators. This first phase is called as Conventional Aeration phase and lagoons are called Conventional Aeration Lagoons. The details are as follows.

**Process Parameters**

| | | |
|---|---|---|
| Type | - | Fixed |
| $O_2$ Transfer rate | - | 1.0 Kg $O_2$/H.P./Hr. |
| MLSS maintained | - | 4500 – 5000 mg/L |
| Retention time | - | 8.0 days approx. |

**12.2.2.1.3.3.2 Clarifier - II**

The overflow from conventional aeration lagoon is passed through clarifiers- II to separate the sludge. The sludge from clarifier- II is recycled back to aeration lagoon I & II to maintain the required MLSS concentration. The excess sludge is sent to decanter centrifuge for drying and disposal. The details are as under.

**Process Parameters**

| | | |
|---|---|---|
| Type | - | Centrally driven |
| COD outlet | - | 5000 – 7000 mg/L |
| COD reduction | - | 80 % approx. |
| BOD out let | - | 600 - 630 mg/L |
| BOD reduction | - | 85 % |

**12.2.2.1.4 Second Phase Aeration System**

**12.2.2.1.4.1 Aeration Lagoon - III (Extended Aeration Lagoon)**

The overflow from clarifier -II is sent to extended aeration lagoon for second phase aeration where fixed type aerators are provided. Here, keeping sludge under suspension oxygenates the effluent. Thereafter, treated effluent is sent to clarifier - III for sludge separation. The details of this lagoon are as follows.

**Process Parameters**

| | | |
|---|---|---|
| Type | - | Fixed |
| $O_2$ Transfer rate | - | 1.0 Kg $O_2$/H.P./Hr. |
| MLSS maintained | - | 4500 – 5000 Mg/L |
| Retention time | - | 4.0 days approx. |

**12.2.2.1.4.2 CLARIFIER - III**

The overflow from aeration lagoon- III is passed through clarifier no III for the separation of sludge. The sludge is recycled back to aeration lagoon-III to maintain the required MLSS concentration. The balanced sludge is dried in sludge drying beds. The details of clarifier no. III are as under. The overflow is collected in a sump.

**Process Parameters**

| | | |
|---|---|---|
| Side Water Depth (SWD) | - | 3.0 meter |
| COD reduction | - | 80 % approx. |
| BOD reduction | - | 85 - 90 % |

**12.2.2.1.5 Reverse Osmosis Plant**

After anaerobic treatment of organic waste by biological process is directly transferred to RO plant.

Treated effluent after bio-methanation is taken into a feed sump. HCL is added to maintain pH of feed in the range 6.8 -7.2. Effluent is pumped into the R.O. plant by feed pump at a pressure of 2-3 $kg/cm^2$. The effluent flows through filter pump into prefilters(Sand & Cartridge Filter).The pre-filters remove foreign matter from the effluent. The filtered clean effluent flows to the suction side of the high pressure pump. High-pressure pump pressurizes the effluent up to 45-65 bars and pumps it into the 1 sit stage of DT Modules. Inside the DT-Modules about 15 % of the effluent is forced by the high pressure through the thin membranes to the product water recovery side. Salt ions and other impurities are rejected by the membrane and flushed out. The reject will have higher total dissolved solids concentrations. The reject have lower pressure than the inlet pressure of effluent. Pressure is further increased by Inline booster pump fitted in between Reject outlet from 1 st stage module stack and inlet to 2 nd stage module stack. In similar fashion, reject from 2 nd stage module stacks goes to 3 rd stage module stacks through Inline booster's pumps. Then reject from 3 rd stage module stack goes to 4 th stage module stack through Inline booster pumps. Reject from RO module stack at high TDS concentration is finally discharged through Servo Motor Control Valve. Total clear water i.e. permeates from all the stages are 50 % of the total effluent fed to the system. The pressure in the membrane modules is automatically adjusted by means of the pressure control motor valve. The motor control valve is fitted in the reject discharge line downstream the membrane modules. The clear water called permeate is continuously monitored/measured through electrode censor and reading displayed at panel. Permeate (clear water) from the plant is used in distillery process for molasses dilution.

#### 12.2.2.1.6 Utilization In Agriculture

##### 12.2.2.1.6.1 Ferity irrigation

Being very rich in organic matters, the utilization of distillery effluents in agricultural fields creates organic fertilization in the soil which raises the pH of the soil, increases availability of certain nutrients and capability to retain water and also improves the physical structure of soil. Mostly the distillery wastewaters are used for pre-sowing irrigation. The post-harvest fields are filled with distillery effluents. After 15-20 days,

when the surface is almost dried, the fields are tilled and the crops are sown and subsequent irrigation is given with fresh water. However, the effluent is diluted 2-3 times before application on crops. Apparently, the irrigation with distillery wastewater seems to be an attractive agricultural practice which not only augments crop yield but also provides a plausible solution for the land disposal of the effluents. One cubic meter of methanated effluent contains nearly 5 kg of potassium, 300 grams of nitrogen and 20 grams of phosphorus. If one centimeter of post methanation effluent is applied on one hectare of agricultural land annually, it will yield nearly 600 kg of potassium, 360 kg of calcium, 100 kg of sulphates, 28 kg of nitrogen and 2 kg of phosphates. The distillery effluent contains 0.6 to 21.5 percent potash as KO, 0.1 to 1.0 percent phosphorus as PO and 0.01 to 1.5 percent Nitrogen as N2.

**12.2.2.1.6.2Composting**

In this process, press mud generated from sugar mill is utilized to produce compost by mixing distillery effluent. Composting with treated effluent treated through bio-methanation plant is also practiced. This system can achieve zero effluent if the press mud quantity matches with the effluent generated.

**12.2.2.2 Modified Approach Of Various Zero Discharge Scheme:**

In the modified approach of distillery effluent treatment Spent wash treatment is proposed by different routes as given below:

(a) Concentration followed by combustion,

(b) Anaerobic digestion with biogas recovery followed by aerobic polishing (Detail of these is already given in previous section)

All of these processes are capital intensive. The incineration process involves an investment of the order of 400% of the distillery cost, whereas the other two processes along with the secondary treatment require an investment of 200-300% of the distillery cost.

The unfavorable economics make it difficult to implement these treatment processes on the plant scale. Because anaerobic digestion and wet oxidation are less expensive, these alternatives are more attractive. However, there is a need for development of a suitable

process with lower investments and higher energy recovery. Many distilleries in India are allowing their effluent for application on land as direct irrigation water, spent wash cake and spent wash-press mud compost. The advances manifesting the possibilities of energy conservation are also discernible in the case of distilleries. The methane gas generated in the digesters is used as a fuel to compensate the energy needs of the industry. A general estimate suggests that the cost of an anaerobic biological digester is recovered within 2-3 years of installation because of substantial saving of coal and other fuels.

#### 12.2.2.2.1 Effluent Concentration Followed By Combustion

In the **Modified Approach of distillery effluent disposal** is by "effluent concentration followed by combustion"

#### 12.2.2.2.1.1 Evaporator System:

Feed is received in a level controlled balance tank and passed through pre-heaters, calandrias and vapor separators of various effects. The evaporation takes place under vacuum, which is maintained mainly by vacuum system. Steam is supplied as a heating medium to high heater and through thermal vapor recompression (TVR) to the first effect jacket. The concentrated product at the desired concentration is continuously taken out from the plant. The evaporating plant comprises of the following equipment:

**Balance Tank:**

It is fitted with feed inlet connection along with a float, operated valve to maintain the liquid level in the tank and outlet connection.

The balance tank is provided with SS legs fitted with SS ball feet for height adjustment.

**Inline Filter:**

This will filter the liquor to remove the foreign suspended particles. It is fitted in line with the balance tank and evaporator with necessary valves and fittings.

**Feed Pump:**

This is a centrifugal pump with sanitary design and SS mechanical shaft seal capable of pumping the required feed rate. The pump has sealing arrangement with stuffing box and

coupled to an electric motor. The pump is complete with SS shroud and SS inlet/outlet ending in SS union of DIN standard.

**Graduated Flow Control Valve:**

This is used for accurate control of the feed rate. The valve is with SS union connections.

**High Heater & Flash Vessel:**

For heating the feed up to the required temperature, the heater is provided with an automatic temperature control system, so as to regulate the steam supply based on the product temperature required.

**Pre-heaters:**

These are of straight tube in SS construction for heating the feed by means of vapour from all effects and the condenser of the plant.

**Calandrias:**

Calandrias have bunch of tubes welded or expanded to the tube plates in a vertical shell and provided with efficient distribution assembly on top for even distribution of feed over the tubes. The bottom of the calandria is made as a container to receive the concentrate and a connection for vapour duct leading to vapour separator.

Calandrias are provided with quick detachable top and bottom covers for visual inspection/manual cleaning, a MS sight glass (fitted with toughened glass) at the bottom of the jacket to monitor the condensate level and necessary connections for steam vapour condensate, non-condensable, air vent, product inlet, concentrate outlet, etc.

The first effect calandria is insulated with mineral wool/rock wool mates of thickness 50 mm and cladded with Al. sheet. Calandrias for other effects are generally designed according to the calandrias for the preceding effects but excluding insulation and cladding.

**Vapour Separators:**

Vapor separators, separate the vapour from concentrate and are normally placed in front of the calandrias. These are connected to receiver bottom of the calandrias with a tangential inlet and a central top outlet vapour duct.

**Condenser:**

It have a bunch of SS tubes mounted in a vertical shell. This can be of four passes. The water is circulated in the tubes and vapour gets condensed on the shell side.

**Concentrate Pump:**

These pumps are of adequate capacity to pump the feed through the calandrias and its separators to the next effect. The pumps are installed with suitable horsepower rating motors. The concentrate pumps have the description as that of feed pump.

**Condensate Pump:**

Extracting out condensate from all effects. The construction is similar to concentrate pumps.

**Vacuum Pump:**

This pump is of liquid ring water sealed type coupled to an electric motor of suitable rating through a flexible coupling. The pump have sufficient capacity to achieve the required vacuum in the plant.

**Vapour Duct:**

This is made of suitable thickness stainless steel for interconnecting the thermal vapour re-compressor, calandrias, vapour separators and condenser. The duct between the vapour re-compressor and the first effect calandria is insulated and clad with MS sheet.

**Seal Water Tank:**

Seal water tank is provided along with water inlet connection with float valve and outlet connection with valve. The function is to supply seal water for all SS pumps.

**Instrumentation :**

**(a)** The panel is equipped with**:**

- 1 set Pressure Controller to control steam pressure at the inlet of thermo-compressor.
- One no. vacuum switch to cut off vacuum pump at higher vacuum.

Digital type Temperature indicators with PT-100 sensors for

- Boiling temperatures in all the effects.
- Temperature in the steam jacket of first calandria.

**(b)** Local Mountings:

- Pressure gauge for indication of the steam pressure before the TVR.
- 1 Set dial type vacuum gauges for indication of vacuum in all effects.
- 1 Set dial type temperature gauges for indication of boiling temperatures in all effects.

**12.2.2.2.1.2 Combustion of SLOP:**

The Slop (concentrated spent wash) from the evaporator and other biomass is used as fuel in specially designed boiler for the generation of steam followed by electricity.

This is a novel technology boiler that has been developed for the utilization of concentrated spentwash as fuel and generation of steam there from.

**12.2.2.3 Recommendations**

Reviewing the magnitude of pollution potential of distillery wastewaters and the experiences gained over years on recovery of residues and treatment of wastewater the following recommendations are made :-

- In-plant control measures for conservation and reuse of water and good house-keeping for prevention of spillage and leakages should be the prerequisite.
- For recovery from the treatment of distillery spentwash, depending on the availability and cost of land in a particular area, simple treatment in anaerobic lagoon to generate biogas followed by treatment in aerated lagoon or oxidation ditch may be considered. Where the availability and cost of land are the main constraints, activated sludge type of aeration treatment in a deep oxidation ditch would be more economical than the conventional or extended aeration sludge process.
- For the treatment of distillery spent wash, removal and/or recovery of yeast should be prerequisite to reduce the load and eliminate certain undue problems in the waste treatment/recovery plants. This recovered yeast can be utilized as a

good cattle feed. Recovery of yeast and their utilization as animal feed and feed supplement might be encouraged not only for reducing the pollution load form the wastewaters but also in providing for a reasonable return on their capital investment of the industry.

- In the countries like ours, where indigenous sources of potash are scarce or not available, recovery of potash from crude ash by evaporation and incineration of spent wash would appear to be an economically attractive alternative. If heat recovery is simultaneously used, the pay back period of the plant can be substantially reduced.
- Anaerobic digestion of spent wash in a closed digester followed by its treatment under an activated sludge process, especially in an oxidation ditch to reduce costs, might be adopted as the most cost-effective system for the distilleries which are located away from sugar factories. Moreover, the treated effluent can be conveniently used for irrigation of cane fields or other crop lands, subsequently.
- Biogas generated from the distillery effluents, can be effectively utilized in production plant boilers thus saving about 50 to 60 percent fuel/steam. The treated effluent having almost all the potash retained in it may be utilized as liquid organic manure.
- The utilization of the distillery effluent in agricultural fields will not only enrich these further with essential plant nutrients like nitrogen, phosphorous and potash but also compensate the expenditure on fertilizers for crop growth. This practice will result in revenue generation and further lead to offsetting the costs substantially.
- Similarly spent wash utilization in bio-composting, where adequate land is available, being a simple process and not involving any heavy machinery is also one of the cost effective methods of disposal. Moreover it is feasible alternative for utilization of treated effluent; as the same generates revenue thus offsetting the costs and further leading to reduction in pay back period.

- Availability of land is a severe constraint, evaporation and incineration of distillery spent wash to recover potash would appear to be the only choice. In spite of high capital investment required for such type of plants, heat recovery would defray significantly the organization and maintenance costs and contribute towards conservation of energy.

## 12.3 ENVIRONMENTAL MANAGEMENT DURING OPERATION STAGE (PULP AND PAPER INDUSTRY)

### 12.3.1 Air environment:

Since steam requirement for the proposed installation of Pulp & Paper plant is met from boiler, load of $SO_2$, NOx, hydrocarbons, flue gases etc. on air environment is expected.

Emission of particulate matter will be expected to generate from handling & processing of raw material, which will be controlled by sprinkling of water on affected area. Further, green belt of the industrial area is adequate to reduce the effect of minor pollutants.

### 12.3.2 Water Environment

It has been reported that black liquor can be segregated by squeezing or by allowing it to drain out from a false bottom. It is observed that 30 to 50% of black liquor can be separated out from straw pulp and only 20% from gunny rag or rope pulp. The segregated BL cannot be discharged into stream or on land except during flood time in the river. Since its volume will be small it can be stored in lagoons for suitable period of time and discharged in a controlled manner into surface waters only during monsoon. This will help in reducing the color, BOD and sodium in the remaining waste water.

Another possible place for segregation is the rejects from centricleaners. These rejects will be small in volume but contain a very large percentage of suspended and settable solids. This waste water is taken through a side hill screen, the rejected sludge is disposed of as solid waste. This method of segregation and treatment would considerably reduce the total load of suspended solids in the combined waste water reaching the clarifier and lessens the problem of their handling in dilute form in the clarifier underflow.

Paper machine waste water contains high amount of fiber which settles rapidly. This can also be recovered by employing suitable recovery system and both the recovered fiber and water can be recycled into the process. This would not only help in reducing the cost

of waste treatment but also generate revenue in the form of extra paper and reduced water requirements.

## STANDARDS FOR DISCHARGE OF EFFLUENTS

The choice of methods for treatment of wastewater depends on the quality requirements for final disposal. The treated effluent will have to be discharged either into sewers, if available, or surface waters. It can also be applied on land for agriculture utilization. Pollution Control Boards has prescribed tolerance limits for Pulp & Paper effluents for discharge.

**EXISTING WASTE WATER DISCHARGE STANDARDS FOR LARGE PULP & PAPER MILLS**

| Parameters | Standards |
|---|---|
| Volume, m3/ton paper | Writing & Printing : 200 (100)*<br>Rayon grade/News print :150 |
| pH | 7.0-8.5 |
| BOD3 at 27deg C mg/I | 350 |
| COD mg/l | 50 |
| TOCL kg/ton paper | 2.0 |

**Figures in brackets are for new mills set up after 1992. (CPCB report)*

**EXISTING DISCHARGE NORMS FOR SMALL PULP & PAPER MILLS**

| Parameters | Mode of Disposal | |
|---|---|---|
| | Inland Surface Water | Land |
| Volume, m3/t paper<br>• Agro based<br>• RCF based | 200 (150)<br>75 (50) | |
| pH | 5.5-9.0 | 5.5-9.0 |
| BOD3, mg/l at 27 deg C<br>3 days | 30 | 100 |
| SS mg/l | 100 | 100 |
| SAR | - | 26 |

### 12.3.2.1 Conventional Approach of Pulp & Paper mill Effluent Treatment

All the usual treatment units are essential for treatment of pulp and paper mill effluent. However, sludge digesters can possibly be eliminated for the following reasons.

1. Primary sludge consisting mostly of cellulosic fiber does not require digestion and can be disposed after dewatering and drying.

2. The volume of the excess secondary sludge is comparatively lower than the primary sludge and this sludge can be returned to the primary setting tank.

It is also possible to simply lagoon the primary and secondary sludge in open lagoons if sufficient land area is available.

The activated sludge requires acclimatization in the initial stages. Since most of these effluents are deficient in the essential nutrients like N and P, supplementation of these nutrients in adequate dose is essential**.** The nutrient requirement of million gallons of effluent having a BOD of 200 mg/l will be as follows:

1. Nitrogen as urea 214 lbs.
2. Phosphorus as phosphoric acid 66 lbs.

As already mentioned the degree of treatment required will depend upon the final mode of disposal, whether on land for irrigation or into sewer, municipal sewer or into inland surface water.

For mills nearer to towns and cities, disposal of their effluent into municipal sewer may prove most practical solution since land values in such situation is likely to be high. For mills situated upcountry near the source of raw material, the land values are likely to be moderate and in absence of any sewers, disposal on land may be the best alternative.

## TREATMENT METHODS FOR SMALL PAPER MILLS
## TREATMENT ALTERNATIVE I

The suggested flow-sheet for treatment alternative I, although similar to alternative II, differs from it in two ways. In this case, it segregate about 50% of black liquor from straw and 20% from rag digesters. The segregated black liquor (4.5 m2 per ton of paper) is proposed to be stored in a lagoon and discharged into river during monsoon.

Other waste water (about 200 m3/ton of paper) after primary clarification are treated in an aerated lagoon instead of activated sludge. Nutrient addition is needed in this case in the same proportion. Detention period in the lagoon will be 5 days. The aerated lagoon will be provided with a silting chamber to prevent escape of solids in the effluent. Normally no excess sludge is expected from aerated lagoon. Primary sludge will be disposed of into the sludge lagoons. Effluent of aerated lagoon is expected to have a BOD

of 30 mg/l and suspended solids of 80 mg/l and is fit for discharge into inland surface waters except for COD and color.

## TREATMENT ALTERNATIVE II

In this alternative, it is proposed to use the combined waste, resulting after segregation of black liquor as suggested in alternatives I, on land for agricultural utilization.

The combined waste water (about 200m3/ton of paper) will be taken through a clarifier to remove the settleable solids. The clarified waste water after mixing with calcium sulphate, (Gypsum), to bring down the percent sodium below 60, will be used on land for irrigation. Depending on the type of soil, crop grown and the climate conditions, a dose of 54 to 108m3 of waste can be applied on land per hectare per day.

It is of importance to mention that the studies carried out so far by NEERI, on agricultural utilization of pulp mill wastes, have indicated that several Kharif and Rabi crops (except 3 varieties of grass and groundnut) have responded favorably when irrigated with pulp mill effluent as such or diluted with plain water.

Continued use of the wastewater on land is likely to create ground water pollution due to percolation of the adsorbed color. This is drawback for this method of disposal.

## TREATMENT AND UTILISATION ON LAND

- In many arid and semiarid regions of our country shortage of water is the limiting factor for agriculture, and hence a need exists for developing and utilizing every source of water.
- Industrial effluents constitute a continuous supply of irrigation water.
- Land disposal of wastes also acts as treatment, since soils help in purifying the wastes. Besides oxidizing the organic matter (BOD) present in the water soils help in removing color and oxidizing some residual organics in the waste which escape biological treatment.
- Continuous use of wastes help in recharging the ground water.
- Nutrients present in the waste will be available to the plants.

- Cost of waste treatment can be reduced because part of the BOD in the waste can be stabilized by the solid and irrigation standards are much more liberal than standards for discharge into surface waters.

## SUITABILITY OF INDUSTRIAL EFFLUENTS

Pollution Control board has suggested tolerance limits for Industrial Effluents for discharge on land.

Characteristics of effluents are important for determining the suitability of water for irrigation purposes include

1. Total dissolved solids
2. Percent sodium
3. Boron and also
4. BOD

It can be seen from Characteristics of effluents that pulp and paper mill effluent can be utilized on land for irrigation after some marginal treatment such as dilution or other corrective treatment, although suspended solids have not been include for classifying in the effluents, pulp and paper mill effluents contain large amount of suspended solids and these have to be removed before use on land.

The sodium content is usually high in pulp mill effluents and needs correction. This is usually done by adding calcium salts such as gypsum to reduce the Sodium Absorption Ratio (SAR) of the effluent. In the case of pulp and paper mill effluent, the causticsier mud that is available can be beneficially used for this purpose.

### COLOR REMOVAL

1. Kraft pulp mills discharge dark brown colored wastes. The color is due to lignin and its derivatives. Only as small fraction of the total lignin of the wood processed comes out in the waste.
2. Although lignin and its derivatives present in the waste are not toxic to human beings, animals and aquatic life, they create aesthetic pollution. Since they are not

readily biodegradable when present in water, they also reduce the utility of the water and increase the cost of its treatment.

3. The COD of l mg of lignin isolated from Kraft black liquor is 1.8 mg. A solution of 1 mg of lignin per liter at pH 7.0 exhibits nearly 10 units of color on platinum-cobalt scale. The same solution has 1.3 Klett units when measured with 42 liter (420 nm) and 1 cm cell path. The color intensity increased with increase in pH and is fairly constant between pH 7 to 8.

4. In the manufacture of 1 tone of bleached paper from bamboo, as much as 40-50 kg of lignin will be discharged into waste. Most of the ligin will be present in the wastes from pulp washing and caustic extraction stage bleaching. In case of straw, used in small mills, as much as 225 kg of lignin per ton of paper will be discharged into the water. This high value is because no chemical recovery is adopted in small mills.

5. Studies on biological degradation of lignin revealed that:

    a. There are only a limited number of micro organisms capable of degrading lignin- higher organisms like fungi are more capable than bacteria.

    b. biological decomposition is extremely slow and incomplete and there seems to be of not much scope for removal of lignin in the existing biological waste treatment methods.

6. Among the chemical methods employing precipitation or coagulation, massive lime treatment for color removal has been found to be technically and e economically feasible. This methods besides achieving over 90% color removal, also results in 20-40% reduction in BOD from the colored pulp will wastes. In India, some mills are presently establishing the massive lime treatment for color removal. Lime recovery is an essential part of this process.

7. A modified lime treatment for color removal using only 1000 mg/l CaO for the total unclarified kraft pulp and paper mill waste with lime recovery system has a great promise as this method also helps in the removal and disposal of the suspended solids in the combined waste.

8. Among the coagulants only alum treatment is still being pursued with some promise.

9. Activated carbon treatment for color removal from raw wastewater may not prove economical. However, activated carbon treatment preceded by massive lime treatment will yield effluents that can be reused in the mill. Such a combination will make activated carbon treatment an economic proposition. A microlime carbon sequence for removal of 90% color and 40% TOC from clarified wastewater of unbleached kraft mill, has been shown to yield reusable water at a relatively low cost compared to massive or minilime activated carbon treatment.

10. Soils as a medium for color removal can be used successfully provided the right type of soil and adequate land are available. This method of disposal of colored pulp mill wastes will be most suited for Indian conditions. The land requirement will be high in most cases.

11. Color removal in the waste from small mills, where black liquor is not recovered, will pose serious problems and prove uneconomical. In such cases, it is desirable to segregate the small volume of strong black liquor and store it in lagoons before discharge into water courses in monsoon. The remaining colored wastes can be used on land or treated by coagulation. This aspect has to be given a serious consideration before locating the mills.

**12.3.2.2 Modified Approach of Discharge Scheme For Pulp And Paper Industry:**

Various sources for generation of pollution load during the paper making process in the pulp and paper mills are given in the Table.

**Table 13.3.2.2.1: Source of effluent generation in Pulp and Paper Mills**

| Sources | Discharge | Intensity of pollution |
|---|---|---|
| Fibrous raw material washing | Washing of raw materials | Small volume with least pollutants. |
| Digester House | Spills & leakages of black liquor & gland cooling water | Small volume but high concentration of pollutants |
| Pulp washing | The final wash often referred as brown stock wash or unbleached wash | Small volume and large quantity of pollutant |

| Sources | Discharge | Intensity of pollution |
|---|---|---|
| Pulp bleaching | Wastewater from chlorination stage having low pH and high chlorolignins, from caustic extraction stage with dark brown colour & high pH as well as chlorolignins from hypochlorite stage | Very large volume with high concentration of pollutants. About 60-65% of wastewater is contributed from this section. The effluents contain toxic chloroorganic compounds. |
| Paper Machine | Often referred to as white water | Volume depending upon the extent of recycling. It contains maximum suspended solids, like fibers, fines and small quantity of dissolved pollutants. |
| Chemical Recovery | Spills of black liquor in the evaporators foul condensates and washing of the causticiser | Small volume, but high pollutants |

Effluent Treatment Plant (ETP) in Pulp and Paper Mills is meant to treat the effluent generated from the different section of the mill as given in the table. The Effluent Treatment Plant (ETP) commonly consists of the following sections:-

- Screening (removal of large size suspended particles)
- Sedimentation (primary clarification)
- Biological treatment
- Secondary clarification

**12.3.2.2.1 Screening**

The effluent containing large size solids like plastics and plastic materials, small logs, paper etc, passes through the manual bar screen where these solids are removed. Some time automatic motorized bar screen are also used for removal of solids.

**12.3.2.2.2 Sedimentation**

After screening influent enters into primary clarifier where floc's are settled down along with suspended solids impurities making fibrous sludge. This fibrous sludge is removed

from the bottom of the primary clarifier through under flow pump, cake of this sludge is formed on the belt press machine. This sludge is sold to paper board manufactures.

#### 12.3.2.2.3 Biological Treatment

In the pulp and paper industry, most of the mills have the aerobic biological system only few paper mills have anaerobic system with aerobic system. After the primary clarifier the effluent (overflow of primary clarifier) goes to biological system where in the presence of oxygen other aerobic bacteria oxidized the most of the organic impurities. Mixed liquor suspended solids (MLSS) is developed in aeration pond by adding nutrients (Nitrogen and Phosphorous) and supplied oxygen.

#### 12.3.2.2.4 Secondary Clarification

After aeration tank, all effluent with MLSS goes to secondary clarifier. Sedimentation takes place in the secondary clarifier where MLSS are settled down and then MLSS is recycled back to aerobic treatment. Some part of the treated effluent is either used in the system or released as such into the receiving stream.

In some cases the pulp and paper mills also incorporate a tertiary clarifier to meet the standard norms set by pollution control board for environmental compliance.

Most of the mills have the facility for treatment of their effluent which is based on either Activated Sludge Process (ASP) or combination of anaerobic treatment + ASP. In recent times there has been increasing practice of use of final treated effluent by mill or the local farmers for horticulture, gardening, irrigation of crops and plantations. Some mills have installed biomethanation system for pretreatment of black liquor followed by conventional aerobic process for treatment of pretreated black liquor along with other waste water. In RCF Based Mills the suspended matter is normally removed by Kroft (Dissolved Air Floatation System) and clarified water is reused in pulping, pulp cleaning and washing process. Some mills are utilizing the treated effluent for land application i.e. irrigation of crops.

#### 12.3.2.2.5 Generation of Absorbable Organic Halides (AOX) & Treatment

The hazardous effect of bleach effluent was considered related to use of elemental chlorine for bleaching of pulp. The major portion of lignin was usually removed in

subsequent bleaching stage of pulp produced with high kappa number (35 to 40) as the conventional pulping process was having limitations to produce pulp of kappa number below 20 and secondly, because environmental issue were not given priority due to non availability of analytical method for testing of effluent for the organo chlorine compounds (AOX).

#### 12.3.2.2.5.1 Formation of Chlorophenolic Compounds

The nature and extent of formation of chlorophenolic compounds are determined primarily by the residual lignin content in the pulp and type of bleaching chemicals employed. The formation of chlorinated phenolic compounds during bleaching of pulp with chlorine based chemicals, which include chlorinated resin acids, fatty acids, chlorinated phenolics, dioxins & furans.

About 80% of chlorine is bound with high molecular weight lignin material (MW>1000D) commonly referred as chlorolignin. These chlorinated compounds was thought to contribute little to acute toxicity due to their inability to penetrate the bacterial cell membranes. Studies conducted revealed that these high molecular weight chlorinates phenolic are slowly decomposed in recipient water, sediments into more active biologically chlorinated catechols and guaiacols. About 20% of low molecular weight chlorinated organic material (MW<1000D) is of main environmental concern. In recent years a considerable research efforts have been made in characterizing with respect to its individual chlorinated compounds particular this fraction is considered to contain compounds which are toxic due to their ability to penetrated the bacterial cell membranes and has tendency to bio accumulate in the fats of higher organism.

In Indian pulp and paper industry due to use of mixed type of raw material, old technology and equipment, generate lots of toxic chemicals including Absorbable Organic Halide (AOX) as waste product which is main concern for all the Indian paper mills. That's why; this research is very beneficial for Indian paper mills for reduction of toxic chemicals (AOX).

#### 12.3.2.2.6 Measure To Reduce The Chloro Phenolic & Phenolic Compound

In 1992, British Columbia governments enacted the Pulp & Mill Liquid Effluent Control Regulations, setting strict AOX limits over a series of stages to eliminated chlorinated

organic compounds within 10 years. Pulp mills had to reduce their actual AOX discharge limit and could follow one of two approaches to eliminate AOX before 2003, ensuring the elimination of chlorine and chlorine dioxide bleaching processes..

Chemical precipitation of chlorinated organic material by iron and or aluminum salts has been reported as a potential AOX removal system (Wilson, D.G. & Holloran, M.F. 1992).

Absorbable organic halides (AOX) can be efficiently reduced by adsorption, ozonation and membrane filtration techniques (D.Pokhrel, T.Viraraghavan, 2004).

Milosevich, G.M. & Hill, D.A. (1992) studied the treatment of bleach plant effluent with lime mud shows that neutralization of bleach plant with lime mud, followed by the addition of alkaline sulphide process liquor was demonstrated to be a practical, cost-effective method of reducing mill AOX discharge. Organic matter from spent bleaching effluents (from chlorination © or extraction € stages, or a mixture of both) was effectively precipitated chemically and AOX in E-stage effluent is reduced upto 73% (Milestein, O.1988). D.W. Francis (1988) also reported that the AOX reduction by combined chemical and biological treatment ranged from 53 to 59% depending on the operating conditions of the biological treatment plant.

Standard practices for end of pipe (EoP) waste water treatment is biotreatment (Activated Sludge Process, Aerated Stabilization basin/Aerated Lagoon, Anaerobic process) which reduce AOX from 8-60% (Gary Hickman, 1995). The activated sludge treatment process has become widely adopted due to its optimization in relation to AOX removal. 40-60% reduction in AOX was observed during effluent treatment process (Gergov et al., 1988). But the AOX reduction achieved in an aerated lagoon are lower at around 20-40 %. The anaerobic process has not has not been tested on the mill scale with the total waste water containing bleach plant effluent because anaerobic bacteria is very sensitive to the bleach chemical (R.Saunamaki, K.Jokinen & M.Savolanien, 1991). The use of micro fungi in waste water treatment is being studied intensively. Tests have already achieved an AOX reduction of around 70% but this method is still at the laboratory stage.

The changed in kraft bio effluent quality were evaluated as a function of increased chlorine dioxide (ClO2) substitution, and ultrafiltration (UF) membrane and

heterogeneous photo catalysis (HP) treatment of extraction (E-stage) waste water prior to aerobic biological treatment.

Fergusan J.F. attempted AOX removal by combining anaerobic treatment and aerobic treatment and found that the AOX reduction were 30-35% with anaerobic treatment and 40-45% with aerobic treatment. And combination of anaerobic and aerobic treatment resulted in to 50-55% reduction in the AOX level.

More attention has been paid to aerobic cultures specially white rot fungi. 40-60% AOX reduction was shown by Phaenerochaete chrysosporium from bleach pulp effluent.

The theory of chemical reactions in for the treatment of effluent is very complex. The chemical reaction are often incomplete, and numerous side reactions with other substances in wastewater may take place. (Metcaff & Eddy).

The secondary effluent treatment in aerated lagoons or activated sludge plants is an important and technologically tired technique for reducing the load of organically material in the mill effluent before discharging it to the recipient. Although initially designed for BOD reduction it is now recognized that biological treatment plants also are effective for controlling discharges of organic & inorganic process are generally also effective in reducing the acute toxicity of kraft mil effluents (Lars Stromberg et al., book, 1996).

The secondary waste water treatment plant of bleached Kraft pulp mills where opted to remove 90-97% BOD but the concomitant removal of organic halogen (AOX) was only 30-60% depending on the mill and method treatment (Saski et al., Book). Measurement made at mill scale biological treatment confirm that a full fladged with good operated plant can reduce AOX about 50% (Saunamaki, R. et al., 1991).

More over the most of the studies have been related to ECF & TCF effluents which are less toxic and easy to handle as compared to conventional method where use of elemental chlorine has thus promoted the closed water cycle concept in these mills. The introduction of elemental chlorine free (ECF) bleaching process and oxygen delignification substantially reduced bleaching chemical use, effectively eliminated AOX

levels and achieved significance decrease in recalcitrant compounds from bleach effluents (Chaparro, T.R. et al 2010).

Traditionally, the internationally Kraft pulp and paper industry has used aerobic biological system, for external treatment of their water waters. In many cases, aerobic lagoons have been installed, because of their ease of operation and good tolerance against shock loads and varying condition. The activated sludge treatment also has wide spread application and in Finish pulp and paper mills a number of plant have been installed (B.Frostell 1994). However there is no reference of application of such technologies for treatment of bleach effluents from conventional chlorine based bleaching sequences as used in Indian mills. The sensitivity of the microtox method has been proven to be comparable to acute toxicity tests with fish and crustaceans in several comparative investigations (B.Eklund et al.).

**12.3.2.2.7 Technological Development for reduction in AOX**

Pulping and bleaching are the thrust areas where remarkable technological developments have taken place in the last two decades in the developed countries to reduce the overall environmental impact (including AOX) associated with pulp and paper industry. In recent years the trend in technology developments or approach for reducing AOX have been:

- Extended delignification (Modified batch pulping process)
- Improved pulp washing
- Oxygen delignification
- Development of Elemental chlorine free (ECF) and Total Chlorine free (TCF) bleaching techniques.

## Modified Pulping

The extended delignification process includes modified cooking like RDH and super batch cooking. The main objectives of these techniques is to reduce the kappa factor (residual lignin in pulp) to the lowest possible level in cooking stage itself, since the conventional pulping process has limitations to cook certain fibrous raw material to low kappa number. High kappa number of unbleached pulp demands more bleaching chemicals and ultimately increase the pollution loads in the mill effluent. These modified

batch cooking and continuous cooking processes are highly energy efficient and produce pulp of low kappa number with improved pulp viscosity.

The other advantages of these processes besides reduction in AOX level are as under:

- Reduced energy consumption by 60-70%
- Reduction of chemical consumption in pulping and bleaching
- Lower kappa number of pulp
- Higher pulp yield with reduced fiber loss
- Improvement in pulp quality leading to improvement in paper machine
- Runnability
- Reduced alkali losses
- Low viscosity of black liquor as a result firing can be done at 75-80% solids
- Less emission of obnoxious gases like Mercaptans
- Reduced TRS emission.kg/t paper

## Improved Pulp Washing

The washing of pulp serves to separate pulp fibers from spent pulping liquor which contains both inorganic cooking chemicals and the organic substances dissolved from fibrous raw materials. Brown stock washers are generally used by the mills for washing of pulps. The efficiency of the washing equipment generally depends upon nature of fiber and equipment used.

Washing of pulp has significant role in influencing not only the process economy through recovery of chemicals used in cooking of raw materials and reduced bleaching costs but also minimize the carryover of organic substances along with pulp to bleaching section and ultimately reduce the environmental impact associated with the discharge of toxic chlorinated phenolic compounds. AOX value in bleach plant effluent is also depend upon the COD carry over with pulp going to bleaching section. In Indian condition COD carry over is high resultant into high AOX value. At certain COD carry over, AOX discharge

from softwood pulp bleaching were clearly higher than the hard wood pulp bleaching (Bloomberg, L. 1990).

In view of improving the washing process, new generation of pulp washing equipment have been introduced in last decade which have minimized washing losses and carryover of organic substances along with pulp to bleach plant. Some of the examples;

- Drum displacer washer
- Screw press in combination with rotary drum washers

Screening operation is also considered an integral part of pulp washing where knots, shives and other impurities are removed. Thus dewatering after screening has the function of final washing stage, when its filtrate is used as wash liquor in previous stages (counter current washing). This is known as "Closed Screening" where specially designed equipment is provided to avoid the risk of foaming due to increased concentration of dissolved salt and organic substances in circulating liquor. The closed screening system is now a common practice employed by the mills in developed countries to reduce pollution.

**Oxygen Delignification Process**

The oxygen delignification which is often termed as extended delignification is a well established technology & almost all mills is developed countries have adopted oxygen delignification to reduce kappa number by 40-50%, chlorine consumption by 50-60% and AOX generation by 60-70%. Some of the mills in developed countries have even adopted two stage oxygen delignification to reduce the kappa number to lowest possible and the spent liquor from oxygen stage is taken to chemical recovery along with black liquor. The efforts are continued to reduce kappa number further below 10 in order to improve the process efficiency and environmental compatibility.

**Modified Bleaching Process**

The bleaching process serves the purpose to extract out the residual lignin and increase the brightness of the pulp used for the manufacture of different grades of bleached variety of paper products. The elemental chlorine is generally used to increase the solubility of the residual lignin from pulp and hypochlorite is used for brightening the pulp. The

release of various chlorinated phenolic compounds including toxic dioxins during bleaching of pulp with chlorine based chemicals particularly elemental chlorine had forced the industry to adopt new elemental chlorine free (ECF) and total chlorine free (TCF) bleaching techniques. Considerable R&D efforts have been put in the development of these techniques.

Thus most of pulp mills abroad have switched over to the elemental chlorine (Cl2) free bleaching (ECF) technology using chlorine dioxide bleaching looking into its advantages in significant reduction in formation of dioxins, furans and AOX related compounds along with improved brightness attainment. Recently ozone has attracted the attention of the paper industry as one of the most effective bleaching agents and some of the mills have adopted the total chlorine free bleaching (TCF) techniques using ozone, oxygen and hydrogen peroxide. The adoption of TCF bleaching has led to the concept of system closure as no toxic chlorinated compounds and recalcitrant are present in TCF effluent. The modern bleaching sequences used by the industry are given as below:

**MODERN ECF & TCF BLEACHING SEQUENCE**

| | |
|---|---|
| ECF | OD(EOP) D(PO), OQ (OP) (De)D,OQZ(EO)D |
| TCF | OQ(EOP) Q (PO), OQ (PO) OQ(PO) PP,OQZQPO |
| O= oxygen, D=Chlorine dioxide, De=Chlorine dioxide with alkalinity added, P=Peroxide Q= Complexing agent, Z=Ozone | |

The pulping and bleaching process employed in Indian pulp and paper mills and in developed countries are as under:

**Pulping & bleaching in Indian & developed countries mills**

| Particulars | Indian Paper Mills | Paper Mills In Developed Countries |
|---|---|---|
| Raw Materials | Mixed | Wood based |
| Pulping Process | Usually Conventional | Modified |
| Pulp washing, carry over kg COD/t of pulp | >20 | <10 |
| Oxygen Delignification | No | Yes |
| Kappa No. | 18-26 | 10-12 |
| Bleaching Practice | Conventional | ECF & TCF |

The application of the new modified pulping and bleaching technologies have been limited mostly to the developed countries primarily due to consistent supply of fibrous raw materials of uniform quality & high scale of operation of the mill. In India, the major bottlenecks in adoption of these technologies have been low scale of operation and use of mixed fibrous raw material. The scale of operation in the mills in developed countries varies between 1000-2000 t/day whereas in Indian mills it lies between 30-850tpd.

Similarly in case of ECF bleaching technologies one of the main requirement for induction of chlorine dioxide stage is the complete changeover from MS to special grades of alloyed stainless steel (SS) system to prevent corrosion. This calls for heavy investments and scrapping the entire system in bleaching section for chlorine dioxide. In recent times the large mills have started partial replacement of chlorine by chlorine dioxide. A few mills have switched over to ECF bleaching.

The adoption of these new technologies involves huge capital investment (around Rs 80-90 crore) as most of these process and equipment are of imported origin. Due to the increased environmental awareness, stringent discharge norms, competitive market the industry is exploring the possibilities of adopting these new technologies for their sustenance in the competitive globalized scenario. However, the element chlorine and hypochlorite are still the dominating bleaching chemicals used in Indian mills (CPPRI Project Reports.).

#### 12.3.2.3 Recommendations

Reviewing the magnitude of pollution potential of Pulp & Paper wastewaters and the experiences gained over years on recovery of residues and treatment of wastewater the following recommendations are made :-

- In-plant control measures for conservation and reuse of water and good house-keeping for prevention of spillage and leakages should be the prerequisite.
- For recovery from the treatment of effluent, depending on the availability and cost of land in a particular area, simple treatment in aerated lagoon. Where the availability and cost of land are the main constraints. Most of the mills have the facility for treatment of their effluent which is based on either Activated Sludge Process (ASP) or combination of anaerobic treatment + ASP.

- Bio-methanation system for pretreatment of black liquor followed by conventional aerobic process for treatment of pretreated black liquor along with other waste water. In RCF Based Mills the suspended matter is normally removed by Kroft (Dissolved Air Floatation System) and clarified back water can be reused in pulping, pulp cleaning and washing process.
- In recent times final treated effluent by mill can be used by local farmers for horticulture, gardening, irrigation of crops and plantations.
- The utilization of the effluent in agricultural fields will not only enrich these further with essential plant nutrients but also compensate the expenditure on fertilizers for crop growth. This practice will result in revenue generation and further lead to offsetting the costs substantially.
- Technological change in Pulp & Paper mill by switch over to the elemental chlorine (Cl2) free bleaching (ECF) technology using chlorine dioxide bleaching looking into its advantages in significant reduction in formation of dioxins, furans and AOX related compounds along with improved brightness attainment.
- In ECF bleaching technologies one of the main requirement for induction of chlorine dioxide stage is the complete changeover from MS to special grades of alloyed stainless steel (SS) system to prevent corrosion. This calls for heavy investments and scrapping the entire system in bleaching section for chlorine dioxide. In recent times the large mills have started partial replacement of chlorine by chlorine dioxide. A few mills have switched over to ECF bleaching. The adoption of these new technologies involves huge capital investment.
- Recently ozone has attracted the attention of the paper industry as one of the most effective bleaching agents and some of the mills have adopted the total chlorine free bleaching (TCF) techniques using ozone, oxygen and hydrogen peroxide. The adoption of TCF bleaching has led to the concept of system closure as no toxic chlorinated compounds and recalcitrant are present in TCF effluent.

## 12.4 ENVIRONMENTAL MANAGEMENT DURING OPERATION STAGE (SUGAR INDUSTRIES)

### 12.4.1 Air environment:

Steam requirement for the sugar plant is met from boiler where bagasse is used as fuel in the boiler in all the sugar mill thus no additional load of CO2, $SO_2$, NOx, hydrocarbons, flue gases etc. on air environment would expected. So negligible air pollution is envisaged from the proposed unit.

Particulate matter will be expected to generate from handling & processing of raw material, which will be controlled by control of dust at source. Further, green belt of the industrial area is sufficient to reduce the effect of pollutants.

Most of the use bagasse as a Sugar mills fuel in boilers, which produces particulate matter, oxides of nitrogen, carbon, sulphur and water The vapors, The particulate matter, usually referred to as fly ash, consists of ash, unburnt bagasse and carbon particles. Fly ash is very light therefore, if pollution control equipments are not Installed, it escapes in the atmosphere through chimney and travels long distances. In such conditions, nearby population suffer from dizziness and irritation in eyes, nose, throat and lungs. The heavier particles, if settle on vegetation then it damages them among the solid waste generated by sugar mills, lime sludge and press mud are important.

### 12.4.2 Water Environment

India is the largest producer of sugar in the World and per capita consumption of sugar in the country is 13.4 kilograms per annum. It is a seasonal industry and operates for about 6 months in a year, normally from November to April. Most of the sugar mills do not have the financial strength to invest on in-plant pollution abatement measures or pollution control equipment.

Sugar mills consume around 1,500-2,000 liters of water and generate about 1,000 liters of wastewater for per ton of cane crushed, the effluent is mainly floor washing wastewater and condensate water, Leakage in valves and glands of the pipeline add sugarcane juice, syrup and molasses in the effluent, The sugar mill effluent has a BOD of 1,000-1,500 mg/liter, but appears relatively clean initially, However after stagnating for sometime, it turns black and start emitting foul odour, If untreated effluent is discharged, in water

courses, It depletes dissolved oxygen In water and makes the environment unfit for aquatic life. If untreated effluent is discharged on land, decaying organic solids and oil and grease clog the soil pores.

For purifying the sugarcane juice from organic matter, dirt and other impurities, milk of lime is Ingenerates lime sludge. The impurities from the sugarcane juice are either vacuum filtered or press have filtered and removed as press mud. In addition to these, solid wastes are also generated from the pollution control facilities, like ETP sludge and flyash collected from the dusting devices.

#### 12.4.2.1 CONVENTIONAL APPROACH OF EFFLUENT TREATMENT FROM SUGAR MILL

A number of organizations claim to have developed pollution control technologies which meet the norms prescribed by the pollution control boards. The sugar mills are hesitant to invest large sums of money on these equipment without knowing the true efficiency or the cost aspects of these equipment.

Till recent years sugar mill waste was finding its way into fresh water stream and polluting water bodies.

Settling is reported to remove 20-30% BOD and more than 80% suspended solids. A continuous flow of sugar waste into river, disturb the aquatic life. Earlier days sugar mill wastewater was reported to be discharged into a swamp measuring approx. 25 to 30 hectare area. A maximum 8days retention time was reported to be sufficient for complete mineralization of organic carbon with a carbon loading of 60 to 170 mg/L organic carbon.

#### 12.4.2.2 MODIFIED APPROACH OF EFFLUENT TREATMENT FROM SUGAR MILL:

Rapid urbanization and industrialization in the developing countries like India pose severe problems in collection, treatment and disposal of effluents. This situation leads to serious public health problems. Unmanaged organic waste fractions from industries, municipalities and agricultural sector decompose in the environment resulting in large scale contamination of land, water and air. These wastes not only represent a threat to the environmental quality but also possess a potential energy value

which is not fully utilized despite the fact that they are cheap and abundant on most parts of the world. In order to protect the water resources from onslaught of these wastes, it is necessary to provide adequate treatment to reduce their pollution potential. For biodegradable impurities, the natural choice is biological treatment, which could either be aerobic or anaerobic. Anaerobic treatment converts the wastewater organic pollutants into small amount of sludge and large amount of biogas as source of energy (Ayati, and Ganjidoust, 2006); whereas aerobic treatment needs external input of energy for aeration. The upflow anaerobic sludge blanket (UASB) reactor is high rate anaerobic treatment system for variety of wastewater.

**12.4.2.2.1 Effluent Treatment Scheme Through Anaerobic /Aerobic Treatment:**

Anaerobic digestion of sugar mill effluents in digester of appropriate size and suitable detention time was also reported to be one of the technique in some of the sugar mill in India.

The most characteristic device of UASB reactor is the three phase separator or settler. The presence of the settler on the top of the digestion zone enables the system to maintain a large sludge mass in the UASB reactor, while effluent essentially free of suspended solids is discharged. There are more than 550 installed sugar industries in the country (Reports of Indian Sugar Mills Association, 2004). Sugar industries generate about 1000 liters of wastewater for every tonne of sugar cane crushed. Because of high BOD content, sugar industry wastewater will deplete dissolved oxygen content of water bodies rendering them unfit for both aquatic life and human uses.

**12.4.2.2.2 Pollution Standards**

The pollution standards stipulate that BOD of effluent should be less than 30 mg/liter for disposal into inland surface waters and less than 100 mg / liter for disposal on land. BOD can be 500 mg / liter, in case land application effluent is envisaged as a secondary treatment system for further removal of BOD.

Regarding water consumption and effluent generation, specified standards are 1,000 Liters and 400 liters respectively for per ton of cane crushed.

As per general emission standards, particulate matter is required to be within 150 mg/Normal cubic meter. In case of horse shoe/pulsating grate and spreader stroker bagasse fired boilers, the particulate matter emission is required to be within 500 mg/ Normal cubic meter and 800 mg/ Normal cubic meter respectively.

**12.4.2.2.3 Pollution Control**

Among the air pollution control of treated equipment; wet collectors and multi-cyclones, can reduce particulate matter in boiler emissions by 90% or more. These equipment can reduce the concentration of particulate matter to 450 mg/ Normal cubic meter.

Double Sulphitation Process, already adopted by most of the sugar industries, reduces the quantity of lime sludge and press mud to a great extent. The lime sludge is usually dumped in low lying areas, whereas press mud is sold to farmers as it can be used as manure. Bagasse is either used as fuel or sold to pulp and paper industry which use them as raw materials. Molasses produced in sugar industry is raw materials for fermentation industries.

There is scope of recycling and reuse of water in sugar mills thereby minimizing water consumption and ultimately effluent quantity. The recycling and reuse of hot condensate water can reduce the water consumption to as low as. 100-200 liters, as against 1,500-2,000 liters per tonne of cane crushed. Proper housekeeping, periodic checking and maintenance of pipe joints, valves and glands further reduces the water consumption and effluent quantity. The effluents from the sugar industry can be treated by aerobic and/or anaerobic process. The anaerobic biological processes (biomethanation followed by oxidation ponds ) has several advantages over aerobic processes (aerated lagoons, activated sludge process). Anaerobic processes are easier to control and operate, produce a lower quantity of sludge and their costs are lower. Anaerobic processes decompose the organic compounds in an atmosphere free of oxygen and consequently require significantly less energy as compared to aerobic processes.

UASB reactor is fabricated from acrylic pipe with one inlet near to the bottom of the reactor for the influent. The effluent outlet is provided near to the top level of the reactor. One opening at the top of the reactor is provided for collection of gas. The three phase separator is designed to meet these requirements. The three phase

separator is provided at about 3/4$^{th}$ distance from the bottom. Baffles are provided to guide gas bubbles into the separator to collect the gas generated and to allow the settling of suspended solids.

The effluent tube is connected to the water seal to avoid the escape of gas through the effluent. The gas out let is connected to a wet gas meter through rubber tubing. Pump is used for feeding the reactor. Brass check valve of ¼ inch size is fixed at the bottom of the reactor to facilitate the sludge withdrawal. The lid of the reactor and other fittings are sealed to maintain anaerobic conditions inside the reactor. The reactor was supported by mild steel framed structure.

**Table 13.4.2.1 Average characteristics of sugar industry wastewater**

| Particulars | Concentration |
|---|---|
| pH | 5.2-6.5 |
| Colour | Reddish Yellow |
| Total suspended solids (mg/L) | 760-800 |
| Volatile Suspended Solids (mg/L) | 173-2190 |
| Total Kjeldahl nitrogen (TKN) (mg/L) | 15-40 |
| Phosphorous (mg/L) | 1.3-2.5 |
| COD (mg/L) | 1000-4340 |
| BOD (mg/L) | 350-2750 |

The samples are collected from the feed tank and from the outlet provided in the reactor and are analyzed immediately after collection.

The flow rate, pH of the influent and effluent and quantity of the biogas and other parameters such as influent and effluent COD, VFA, alkalinity and methane content of the biogas are analyzed.

The COD, total Kjeldahl nitrogen (TKN), phosphorous concentrations in the feed are analyzed. Total solids (volatile and suspended) and BOD are measured at steady state conditions.

The performance parameters such as pH, VFA, solids, alkalinity, COD, BOD, TKN, phosphorous, sulphates, SVI and specific gravity of sludge are analyzed as per procedure detailed in Standard Methods (1995).

As the Sugar industries is of seasonal in nature and operates only from November to April, the production of wastewater will obviously be mostly during this period. For rest

of the period sugar waste will not be produced. Therefore to keep biomass active in an anaerobic waste treatment system, such as anaerobic digestion, fixed film reactor including fixed film bed and fluidized bed posed a serious problem. However UASB will be having active biomass in quite large in quantity compared to other anaerobic reactor. Thus UASB will be most suitable and become cost effective due to biogas generation and saving of fuel in boiler for steam generation.

Sugar industries are using modified approach of effluent treatment. UASB is identified as most effective effluent treatment equipment/technology in terms of operation. UASB design is feasible to treat sugar industry wastewater efficiently up to an OLR of 16 g COD/L. d. with a COD removal efficiency of 89% at much lower HRT of 6 h. Methane rich (more than 75%) biogas can be produced at the rate of 4.66 L/L. d. These methane rich biogas is used in boiler for thermal energy generation.

The final treated Effluent is utilized through aerobic bio-composting process with press mud and irrigation of the surrounding agricultural land.

#### 12.4.2.3 Recommendations

Reviewing the magnitude of pollution potential of sugar mill wastewaters and the experiences gained over years on recovery of residues and treatment of wastewater the following recommendations are made :-

- In-plant control measures for conservation and reuse of water and good house-keeping for prevention of spillage and leakages should be the prerequisite.
- For recovery from the treatment of sugar mill effluent, depending on the availability and cost of land in a particular area, simple treatment in anaerobic lagoon to generate biogas followed by treatment in aerated lagoon or oxidation ditch may be considered. Where the availability and cost of land are the main constraints, activated sludge type of aeration treatment in a deep oxidation ditch would be more economical than the conventional or extended aeration sludge process.
- Biogas generated from the effluents, can be effectively utilized in plant boilers as fuel.

- It is recommended that the effluent shall be utilized through bio-composting process with press mud and irrigation of the surrounding agricultural land to preserve the ground water.

# 13 SUMMARY AND CONCLUSION

This study reveals that ambient air quality of Kashipur industrial area is presently within limit of NAAQS. As per statically analysis ambient air quality of Kashipur city, we have concluded that air quality status is deteriorating as level of SO2 & SPM in on increasing path.

Noise level is found higher near study area Kashipur city & Gangapur Gosain due to vehicular movement. Although noise level of monitoring stations is found within limit. The study area near IGL experience a marginal increase in ambient noise level due to the construction activity, the traffic for loading, unloading, fabrication and handling of equipment. The marginal increase of Noise level is reversible and localized in nature and mainly confined to the day hours and still found within limit.

The result revealed that there was significant variation in some physicochemical parameters and most of the parameters were in the normal range and indicates better quality of ground water. It has been found that the water is best for drinking purpose in all the areas. In general all the parameters are within the range of standard values prescribed by various agencies.

Surface water samples collected from Kosi river, Mahadev stream, Bahela river for physico-chemical parameters monitoring. In general all the parameters are within the range of standard values prescribed by various agencies. The water of Khokratal is found highly contaminated during the course of study and it is unfit for consumption, domestic and irrigation purposes.

The pH of soil samples was found to be more towards basic during monitoring. Conductance value and Chlorides is low. The concentrations of sodium and potassium in soil samples represent the use of chemical fertilizers in the surrounding agrifields.

Thus as per the study it is emphasized that all industry should be forced to adopt batter pollution control device for air and water. To control the SO2 level we need to have sulfur recovery system at source in industry and effective dust collection equipment should be installed at source.

One of the most important environmental problems faced by the world is management of wastes.

Now-a-days emphasis is laid on waste minimization and revenue generation through byproduct recovery. Pollution prevention focuses on preventing the generation of wastes, while waste minimization refers to reducing the volume or toxicity of hazardous wastes by water recycling and reuse, and process modifications and the byproduct recovery as a fall out of manufacturing process creates ample scope for revenue generation thereby offsetting the costs substantially.

The cost of effluent treatment in distilleries is likely to be compensated substantially by availability of methane gas. Effluent application will reduce the nutrient requirement through fertilizers. However, high salt load, mainly potassium and sulphur, into the soil system may hamper the sustained crop yields due to continued long-term application of effluents. Therefore the effect on crop productivity has to be visualized on long-term and sustainable basis. Application of post methanation effluent suitably diluted according to crop requirements and soil conditions seems to be viable alternative. If all the distilleries present in India resort to biomethanation, then approximately 2.0 million cubic meters of biogas shall be generated per day, with a calorific value of approximately 5000 Kcal/m. This is equivalent to saving of 2240 tons of coal per day, in turn avoiding CO2 of about 3100 tons per day.

The present study coupled with the corresponding techno market survey has been aimed at reviewing the existing technological status of treatment and disposal of distillery spent-wash in our country and comparing with that of the contemporary technologies, thus identifying the gaps in the technologies and suggesting an action plan for overcoming these. Some relative issues in the areas of quality criteria with respect to gaps in technologies and financial implication in implementing the technological options, has been highlighted in this study. It has to be stressed that recovery from the distillery effluents is a better way to reduce the cost of wastewater treatment for decreasing its pollution level which is actually a very costly affair.

So this is a matter great importance for the Indian distilleries and breweries. Various recommendations are given for the establishment of recovery plants in India. It has also

been elucidated during the study that several technological options that are available in our country need to be exploited to the maximum so that, this will help to control the pollution created by the distillery wastewaters and also enable to derive by-products which are commercially beneficial.

In Pulp & Paper mill bio-methanation system for pretreatment of black liquor followed by conventional aerobic process for treatment of pretreated black liquor along with other waste water will be recommended. In RCF Based Mills the suspended matter is normally removed by Kroft (Dissolved Air Floatation System) and clarified back water can be reused in pulping, pulp cleaning and washing process. In recent times final treated effluent by mill can be used by local farmers for horticulture, gardening, irrigation of crops and plantations.

Technological change in Pulp & Paper mill by switch over to the elemental chlorine (Cl2) free bleaching (ECF) technology using chlorine dioxide bleaching looking into its advantages in significant reduction in formation of dioxins, furans and AOX related compounds along with improved brightness attainment.

As the Sugar industries is of seasonal in nature and operates only from November to April, the production of wastewater will obviously be mostly during this period. For rest of the period sugar west will not be produced. Therefore to keep biomass active in an anaerobic waste treatment system, such as anaerobic digestion, fixed film reactor including fixed film bed and fluidized bed posed a serious problem. However UASB will be having active biomass in quite large in quantity compared to other anaerobic reactor. Thus UASB will be most suitable and become cost effective due to biogas generation and saving of fuel in boiler for steam generation. Sugar effluent is utilized through bio-composting process with press mud and irrigation of the surrounding agricultural land to preserve the ground water

Effluent from industry should be treated at source before discharge to surface water.

It is a development that meets the needs of today's generation without compromising those of future generations. In view of this concept there is need of the time that EIA comparative studies should be conducted at periodic intervals to monitor the environmental impacts due to continual progressing with advanced technologies and

growth of industrial sectors along with all socio-economic changes with Sustainable development.

With the available present scenario and industrial growth rate, the environmental indicators / parameters are also predicted up to 10 years period. This study concludes with understanding of the impacts and changes with available technologies for pollution abatements in an industrial area of Kashipur. From this study we may perceive that the present environmental status w.r.t. the various indicators are within prescribed limits.

# TABLE

**Table 1: ON-SITE MICROMETEOROLOGICAL SUMMARY (MARCH TO MAY 2011)**

| March 2011 | | | | |
|---|---|---|---|---|
| **Parameter** | **Max** | **Avg** | **Min** | **Sum** |
| Max Temperature | 34 °C | 30 °C | 21 °C | |
| Mean Temperature | 28 °C | 23 °C | 16 °C | |
| Min Temperature | 22 °C | 17 °C | 10 °C | |
| Precipitation | 1.8 mm | 0.0 mm | 0.1 mm | 4.00 mm |
| Wind Speed | 11 km/h | 1 km/h | 0 km/h | |
| Relative Humidity | 92.0 % | 54.5 % | 17.0 % | |

| April,2011 | | | | |
|---|---|---|---|---|
| **Parameter** | **Max** | **Avg** | **Min** | **Sum** |
| Max Temperature | 39 °C | 35 °C | 30 °C | |
| Mean Temperature | 32 °C | 28 °C | 25 °C | |
| Min Temperature | 26 °C | 21 °C | 17 °C | |
| Precipitation | 1.7 mm | 0.0 mm | 0.1 mm | 4.60 mm |
| Wind Speed | 15 km/h | 1 km/h | 0 km/h | |
| Relative Humidity | 100.0 % | 45.4% | 16.0 % | |

| May 2011 | | | | |
|---|---|---|---|---|
| **Parameter** | **Max** | **Avg** | **Min** | **Sum** |
| Max Temperature | 42 °C | 37 °C | 28 °C | |
| Mean Temperature | 34 °C | 30 °C | 24 °C | |
| Min Temperature | 29 °C | 25 °C | 19 °C | |
| Precipitation | 2.0 mm | 0.1 mm | 0.3 mm | 8.80 mm |
| Wind speed | 28 km/h | 2 km/h | 0 km/h | |
| Relative Humidity | 100.0 % | 55.3% | 16.0 % | |

## Table 2: CLIMATOLOGICAL DATA FOR MARCH 2011

| Date | Temp. (°C) | | | Humidity (%) | | | Dew Point (°C) | | | Wind (km/h) | | | Precip. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min. | Max. | Avg | Min. | Max. | Avg | Min. | Max. | Avg | Min. | Max. | Avg | (mm) |
| 1 | 10.0 | 21.0 | 16.0 | 60 | 77 | 69 | 10.0 | 15.0 | 12.0 | - | 4.0 | 2.0 | 0 |
| 2 | 13.0 | 27.0 | 20.0 | 35 | 82 | 61 | 12.0 | 15.0 | 14.0 | - | 4.0 | 1.0 | 0 |
| 3 | 15.0 | 22.0 | 18.0 | 56 | 90 | 72 | 13.0 | 16.0 | 15.0 | - | 6.0 | 2.0 | 0 |
| 4 | 14.0 | 22.0 | 18.0 | 60 | 92 | 77 | 14.0 | 19.0 | 16.0 | - | 7.0 | 2.0 | 1 |
| 5 | 11.0 | 28.0 | 17.0 | 24 | 90 | 66 | 11.0 | 14.0 | 13.0 | - | 6.0 | 2.0 | 0 |
| 6 | 12.0 | 29.0 | 20.0 | 34 | 83 | 63 | 12.0 | 13.0 | 13.0 | - | 4.0 | 1.0 | 0 |
| 7 | 11.0 | 29.0 | 20.0 | 34 | 86 | 61 | 12.0 | 16.0 | 14.0 | - | 7.0 | 4.0 | 0 |
| 8 | 16.0 | 29.0 | 22.0 | 33 | 85 | 60 | 14.0 | 17.0 | 15.0 | - | 4.0 | 4.0 | 0 |
| 9 | 13.0 | 28.0 | 20.0 | 40 | 85 | 68 | 15.0 | 17.0 | 16.0 | - | 4.0 | 2.0 | 0 |
| 10 | 13.0 | 29.0 | 21.0 | 17 | 71 | 37 | 7.0 | 14.0 | 10.0 | - | 4.0 | 1.0 | 0 |
| 11 | 15.0 | 30.0 | 22.0 | 24 | 52 | 38 | 8.0 | 10.0 | 9.0 | - | 4.0 | 2.0 | 0 |
| 12 | 16.0 | 28.0 | 22.0 | 33 | 70 | 49 | 12.0 | 14.0 | 13.0 | - | 4.0 | 1.0 | 0 |
| 13 | 15.0 | 30.0 | 22.0 | 25 | 73 | 52 | 11.0 | 15.0 | 13.0 | - | 4.0 | 1.0 | 0 |
| 14 | 17.0 | 30.0 | 24.0 | 25 | 66 | 53 | 13.0 | 18.0 | 15.0 | - | 4.0 | 1.0 | 0 |
| 15 | 18.0 | 31.0 | 24.0 | 32 | 78 | 56 | 16.0 | 19.0 | 17.0 | - | 0.0 | 0.0 | 0 |
| 16 | 20.0 | 31.0 | 26.0 | 30 | 75 | 53 | 16.0 | 18.0 | 17.0 | - | 4.0 | 0.0 | 0 |
| 17 | 20.0 | 31.0 | 26.0 | 34 | 71 | 58 | 16.0 | 21.0 | 18.0 | - | 2.0 | 0.0 | 0 |
| 18 | 21.0 | 32.0 | 26.0 | 41 | 75 | 59 | 19.0 | 21.0 | 20.0 | - | 0.0 | 0.0 | 0 |
| 19 | 21.0 | 33.0 | 27.0 | 26 | 85 | 56 | 16.0 | 20.0 | 19.0 | - | 2.0 | 0.0 | 0 |
| 20 | 22.0 | 34.0 | 28.0 | 26 | 68 | 46 | 13.0 | 20.0 | 17.0 | - | 4.0 | 0.0 | 0 |
| 21 | 17.0 | 32.0 | 24.0 | 17 | 61 | 43 | 9.0 | 16.0 | 13.0 | - | 4.0 | 1.0 | 0 |
| 22 | 16.0 | 33.0 | 24.0 | 18 | 66 | 46 | 12.0 | 15.0 | 14.0 | - | 6.0 | 3.0 | 0 |
| 23 | 17.0 | 33.0 | 22.0 | 27 | 54 | 40 | 12.0 | 14.0 | 13.0 | - | 4.0 | 2.0 | 0 |
| 24 | 18.0 | 34.0 | 26.0 | 18 | 54 | 40 | 12.0 | 17.0 | 15.0 | - | 4.0 | 2.0 | 0 |
| 25 | 19.0 | 34.0 | 26.0 | 21 | 63 | 43 | 14.0 | 16.0 | 15.0 | - | 6.0 | 1.0 | 0 |
| 26 | 19.0 | 33.0 | 26.0 | 35 | 70 | 54 | 14.0 | 20.0 | 17.0 | - | 4.0 | 2.0 | 0 |
| 27 | 20.0 | 34.0 | 27.0 | 28 | 64 | 50 | 17.0 | 20.0 | 18.0 | - | 4.0 | 0.0 | 0 |
| 28 | 19.0 | 31.0 | 25.0 | 43 | 63 | 55 | 15.0 | 20.0 | 18.0 | - | 4.0 | 0.0 | 0 |
| 29 | 20.0 | 31.0 | 26.0 | 40 | 74 | 55 | 17.0 | 19.0 | 18.0 | - | 4.0 | 2.0 | 0 |
| 30 | 17.0 | 30.0 | 24.0 | 41 | 88 | 61 | 17.0 | 20.0 | 19.0 | - | 11.0 | 4.0 | 0 |
| 31 | 19.0 | 32.0 | 26.0 | 20 | 75 | 50 | 11.0 | 18.0 | 15.0 | - | 6.0 | 1.0 | 0 |

## Table 3: CLIMATOLOGICAL DATA FOR APRIL-2011

| SL. | Temp. (°C) | | | Humidity (%) | | | Dew Point (°C) | | | Wind (km/h) | | | Precip. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NO. | Min. | Max. | Avg | Min. | Max. | Avg | Min. | Max. | Avg | Min. | Max. | Avg | (mm) |
| 1 | 18.0 | 34.0 | 26.0 | 26 | 68 | 48 | 15.0 | 17.0 | 16.0 | - | 4.0 | 1.0 | 0 |
| 2 | 21.0 | 33.0 | 27.0 | 20 | 55 | 41 | 13.0 | 16.0 | 15.0 | - | 4.0 | 0.0 | 0 |
| 3 | 20.0 | 33.0 | 26.0 | 23 | 39 | 33 | 11.0 | 15.0 | 12.0 | - | 4.0 | 3.0 | 0 |
| 4 | 18.0 | 32.0 | 25.0 | 6 | 50 | 25 | -1.0 | 12.0 | 7.0 | - | 4.0 | 0.0 | 0 |
| 5 | 17.0 | 34.0 | 26.0 | 7 | 41 | 28 | 3.0 | 12.0 | 8.0 | - | 2.0 | 1.0 | 0 |
| 6 | 18.0 | 35.0 | 26.0 | 8 | 56 | 31 | 4.0 | 15.0 | 10.0 | - | 0.0 | 0.0 | 0 |
| 7 | 20.0 | 34.0 | 27.0 | 11 | 47 | 27 | 7.0 | 13.0 | 10.0 | - | 4.0 | 1.0 | 0 |
| 8 | 19.0 | 35.0 | 27.0 | 9 | 45 | 28 | 5.0 | 12.0 | 10.0 | - | 4.0 | 2.0 | 0 |
| 9 | 20.0 | 35.0 | 28.0 | 14 | 42 | 29 | 10.0 | 14.0 | 12.0 | - | 0.0 | 0.0 | 0 |
| 10 | 21.0 | 33.0 | 27.0 | 19 | 51 | 34 | 12.0 | 16.0 | 14.0 | - | 7.0 | 1.0 | 0 |
| 11 | 21.0 | 36.0 | 28.0 | 18 | 52 | 37 | 14.0 | 16.0 | 15.0 | - | 0.0 | 0.0 | 0 |
| 12 | 24.0 | 35.0 | 30.0 | 21 | 52 | 36 | 15.0 | 19.0 | 17.0 | - | 9.0 | 2.0 | 1 |
| 13 | 18.0 | 34.0 | 28.0 | 30 | 100 | 55 | 16.0 | 19.0 | 18.0 | - | 6.0 | 2.0 | 0 |
| 14 | 18.0 | 34.0 | 26.0 | 18 | 75 | 41 | 12.0 | 18.0 | 15.0 | - | 4.0 | 1.0 | 0 |
| 15 | 22.0 | 34.0 | 28.0 | 18 | 63 | 42 | 13.0 | 18.0 | 16.0 | - | 2.0 | 0.0 | 0 |
| 16 | 22.0 | 36.0 | 29.0 | 17 | 57 | 35 | 13.0 | 17.0 | 15.0 | - | 0.0 | 0.0 | 0 |
| 17 | 22.0 | 36.0 | 30.0 | 16 | 68 | 34 | 12.0 | 18.0 | 15.0 | - | 15.0 | 3.0 | 0 |
| 18 | 19.0 | 32.0 | 26.0 | 31 | 91 | 61 | 17.0 | 21.0 | 19.0 | - | 7.0 | 4.0 | 0 |
| 19 | 21.0 | 36.0 | 28.0 | 8 | 66 | 36 | 6.0 | 18.0 | 13.0 | - | 4.0 | 1.0 | 0 |
| 20 | 21.0 | 36.0 | 28.0 | 6 | 44 | 27 | 2.0 | 15.0 | 11.0 | - | 2.0 | 0.0 | 0 |
| 21 | 22.0 | 36.0 | 29.0 | 10 | 43 | 24 | 6.0 | 13.0 | 10.0 | - | 6.0 | 1.0 | 0 |
| 22 | 22.0 | 37.0 | 30.0 | 9 | 41 | 24 | 7.0 | 14.0 | 11.0 | - | 4.0 | 2.0 | 0 |
| 23 | 22.0 | 37.0 | 28.0 | 10 | 41 | 24 | 8.0 | 13.0 | 11.0 | - | 4.0 | 1.0 | 0 |
| 24 | 23.0 | 38.0 | 30.0 | 10 | 46 | 27 | 9.0 | 18.0 | 14.0 | - | 4.0 | 0.0 | 0 |
| 25 | 24.0 | 38.0 | 31.0 | 17 | 36 | 29 | 13.0 | 18.0 | 15.0 | - | 4.0 | 1.0 | 0 |
| 26 | 27.0 | 30.0 | 28.0 | 38 | 51 | 43 | 14.0 | 18.0 | 17.0 | - | 7.0 | 5.0 | 0 |
| 27 | 23.0 | 35.0 | 29.0 | 24 | 63 | 47 | 17.0 | 20.0 | 18.0 | - | 2.0 | 0.0 | 0 |
| 28 | 25.0 | 37.0 | 31.0 | 22 | 53 | 39 | 18.0 | 23.0 | 19.0 | - | 2.0 | 0.0 | 0 |
| 29 | 26.0 | 39.0 | 32.0 | 21 | 58 | 37 | 18.0 | 21.0 | 19.0 | - | 2.0 | 0.0 | 0 |
| 30 | 26.0 | 39.0 | 30.0 | 18 | 65 | 39 | 15.0 | 21.0 | 19.0 | - | 4.0 | 2.0 | 0 |

## Table 4: CLIMATOLOGICAL DATA FOR MAY-2011

| SL. | Temp. (°C) | | | Humidity (%) | | | Dew Point (°C) | | | Wind (km/h) | | | Precip. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NO. | Min. | Max. | Avg | Min. | Max. | Avg | Min. | Max. | Avg | Min. | Max. | Avg | (mm) |
| 1 | 25.0 | 39.0 | 32.0 | 17 | 62 | 39 | 16.0 | 21.0 | 18.0 | - | 4.0 | 2.0 | 0 |
| 2 | 26.0 | 39.0 | 31.0 | 16 | 40 | 29 | 14.0 | 17.0 | 16.0 | - | 0.0 | 0.0 | 0 |
| 3 | 26.0 | 38.0 | 32.0 | 20 | 82 | 39 | 12.0 | 21.0 | 18.0 | - | 0.0 | 0.0 | 0 |
| 4 | 27.0 | 38.0 | 32.0 | 20 | 56 | 36 | 15.0 | 20.0 | 18.0 | - | 7.0 | 2.0 | 0 |
| 5 | 24.0 | 36.0 | 30.0 | 26 | 56 | 39 | 18.0 | 20.0 | 19.0 | - | 6.0 | 2.0 | 0 |
| 6 | 25.0 | 37.0 | 31.0 | 32 | 70 | 45 | 17.0 | 22.0 | 21.0 | - | 4.0 | 3.0 | 2 |
| 7 | 21.0 | 35.0 | 28.0 | 32 | 76 | 50 | 19.0 | 21.0 | 20.0 | - | 2.0 | 1.0 | 0 |
| 8 | 24.0 | 37.0 | 30.0 | 24 | 68 | 41 | 16.0 | 20.0 | 18.0 | - | 4.0 | 1.0 | 0 |
| 9 | 25.0 | 39.0 | 32.0 | 27 | 57 | 44 | 19.0 | 22.0 | 20.0 | - | 2.0 | 1.0 | 0 |
| 10 | 26.0 | 40.0 | 33.0 | 22 | 53 | 37 | 15.0 | 21.0 | 20.0 | - | 4.0 | 1.0 | 0 |
| 11 | 25.0 | 40.0 | 32.0 | 25 | 55 | 39 | 17.0 | 22.0 | 20.0 | - | 4.0 | 1.0 | 0 |
| 12 | 28.0 | 39.0 | 32.0 | 28 | 58 | 44 | 21.0 | 22.0 | 22.0 | - | 0.0 | 0.0 | 0 |
| 13 | 25.0 | 39.0 | 32.0 | 24 | 57 | 39 | 19.0 | 22.0 | 20.0 | - | 18.0 | 8.0 | 0 |
| 14 | 26.0 | 40.0 | 30.0 | 23 | 56 | 40 | 19.0 | 21.0 | 20.0 | - | 4.0 | 1.0 | 0 |
| 15 | 29.0 | 41.0 | 35.0 | 28 | 48 | 35 | 18.0 | 22.0 | 20.0 | - | 0.0 | 0.0 | 0 |
| 16 | 27.0 | 40.0 | 32.0 | 33 | 49 | 44 | 18.0 | 27.0 | 22.0 | - | 0.0 | 0.0 | 0 |
| 17 | 27.0 | 42.0 | 34.0 | 30 | 67 | 51 | 22.0 | 28.0 | 26.0 | - | 6.0 | 3.0 | 0 |
| 18 | 27.0 | 38.0 | 32.0 | 44 | 68 | 56 | 22.0 | 27.0 | 25.0 | - | 4.0 | 2.0 | 0 |
| 19 | 25.0 | 36.0 | 30.0 | 43 | 77 | 59 | 21.0 | 24.0 | 23.0 | - | 7.0 | 5.0 | 0 |
| 20 | 24.0 | 36.0 | 30.0 | 48 | 89 | 66 | 24.0 | 26.0 | 25.0 | - | 6.0 | 2.0 | 0 |
| 21 | 19.0 | 28.0 | 24.0 | 51 | 79 | 65 | 18.0 | 23.0 | 21.0 | - | 17.0 | 3.0 | 1 |
| 22 | 20.0 | 34.0 | 27.0 | 35 | 84 | 54 | 19.0 | 21.0 | 20.0 | - | 4.0 | 2.0 | 0 |
| 23 | 23.0 | 36.0 | 30.0 | 26 | 88 | 55 | 18.0 | 21.0 | 20.0 | - | 6.0 | 2.0 | 0 |
| 24 | 25.0 | 36.0 | 30.0 | 30 | 56 | 46 | 20.0 | 22.0 | 20.0 | - | 4.0 | 2.0 | 0 |
| 25 | 27.0 | 40.0 | 34.0 | 26 | 60 | 40 | 17.0 | 25.0 | 21.0 | - | 28.0 | 4.0 | 0 |
| 26 | 25.0 | 37.0 | 29.0 | 29 | 60 | 47 | 20.0 | 22.0 | 21.0 | - | 4.0 | 1.0 | 0 |
| 27 | 20.0 | 30.0 | 25.0 | 55 | 96 | 73 | 20.0 | 24.0 | 22.0 | - | 0.0 | 0.0 | 0.2 |
| 28 | 24.0 | 37.0 | 30.0 | 36 | 80 | 55 | 22.0 | 26.0 | 24.0 | - | 4.0 | 1.0 | 0 |
| 29 | 26.0 | 36.0 | 31.0 | 42 | 79 | 57 | 24.0 | 25.0 | 24.0 | - | 6.0 | 1.0 | 0 |
| 30 | 21.0 | 33.0 | 27.0 | 51 | 100 | 72 | 21.0 | 25.0 | 23.0 | - | 4.0 | 2.0 | 0 |
| 31 | 22.0 | 32.0 | 27.0 | 51 | 89 | 69 | 22.0 | 24.0 | 23.0 | - | 2.0 | 1.0 | 0 |

**Table 5: SUMMARY OF AVERAGE VALUE OF SUSPENDED PARTICULAR MATTER (SPM) IN µg/m3**

| SN | CODE | LOCATION | AVERAGE VALUE OF SUSPENDED PARTICULAR MATTER (SPM) IN µg/m3 | | | |
|---|---|---|---|---|---|---|
| | | | 1998 | 2003 | 2010 | 2011 |
| 1 | AAQ-1 | ON SITE | 74 | 218 | | 164.1 |
| 2 | AAQ-2 | GINNI KHERA | | | | 155.2 |
| 3 | AAQ-3 | DHAKIA KALAN | | | | 164.3 |
| 4 | AAQ-4 | DHABORA MUSTAKHAM | | | | 149.1 |
| 5 | AAQ-5 | BARKHERI | | 215 | 161.4 | 144.6 |
| 6 | AAQ-6 | BARKERA PANDE | 97 | | | 150.7 |
| 7 | AAQ-7 | NANDRAMPUR | | | | 168.4 |
| 8 | AAQ-8 | KHARAKPUR DEVIPURA | | | | 143.6 |
| 9 | AAQ-9 | KASHIPUR | 108 | | 160.1 | 176.5 |
| 10 | AAQ-10 | GANGAPUR GOSAIN | 100 | | | 154.7 |

**Table 6: SUMMARY OF AVERAGE VALUE OF PARTICULAR MATTER ($PM_{2.5}$) IN µg/m3**

| SN | CODE | LOCATION | AVERAGE VALUE OF SUSPENDED PARTICULAR MATTER (PM2.5) IN µg/m3 | | | |
|---|---|---|---|---|---|---|
| | | | 1998 | 2003 | 2010 | 2011 |
| 1 | AAQ-1 | ON SITE | | | | 62.4 |
| 2 | AAQ-2 | GINNI KHERA | | | | 68.1 |
| 3 | AAQ-3 | DHAKIA KALAN | | | | 54.8 |
| 4 | AAQ-4 | DHABORA MUSTAKHAM | | | | 55.3 |
| 5 | AAQ-5 | BARKHERI | | | 60.7 | 52.9 |
| 6 | AAQ-6 | BARKERA PANDE | | | | 52.4 |
| 7 | AAQ-7 | NANDRAMPUR | | | | 57.6 |
| 8 | AAQ-8 | KHARAKPUR DEVIPURA | | | | 63.5 |
| 9 | AAQ-9 | KASHIPUR | | | 59.1 | 75.5 |
| 10 | AAQ-10 | GANGAPUR GOSAIN | | | | 65.6 |

## Table 7: SUMMARY OF AVERAGE VALUE OF PARTICULAR MATTER ($PM_{10}$) IN µg/m3

| SN | CODE | LOCATION | AVERAGE VALUE OF SUSPENDED PARTICULAR MATTER (PM10) IN µg/m3 | | | |
|---|---|---|---|---|---|---|
| | | | 1998 | 2003 | 2010 | 2011 |
| 1 | AAQ-1 | ON SITE | | | | 22.4 |
| 2 | AAQ-2 | GINNI KHERA | | | | 19.9 |
| 3 | AAQ-3 | DHAKIA KALAN | | | | 21.1 |
| 4 | AAQ-4 | DHABORA MUSTAKHAM | | | | 19.3 |
| 5 | AAQ-5 | BARKHERI | | | 20.4 | 20.5 |
| 6 | AAQ-6 | BARKERA PANDE | | | | 19.6 |
| 7 | AAQ-7 | NANDRAMPUR | | | | 20.4 |
| 8 | AAQ-8 | KHARAKPUR DEVIPURA | | | | 21.2 |
| 9 | AAQ-9 | KASHIPUR | | | 19.9 | 22.8 |
| 10 | AAQ-10 | GANGAPUR GOSAIN | | | | 20.7 |

**Table 8: SUMMARY OF AVERAGE VALUE OF SULFUR DI OXIDE ($SO_2$) IN $\mu g/m^3$**

| SN | CODE | LOCATION | AVERAGE VALUE OF Sulfur di Oxide (SO2) IN µg/m3 | | | |
|---|---|---|---|---|---|---|
| | | | 1998 | 2003 | 2010 | 2011 |
| 1 | AAQ-1 | ON SITE | 3.5 | 7.1 | | 21.5 |
| 2 | AAQ-2 | GINNI KHERA | | | | 21.3 |
| 3 | AAQ-3 | DHAKIA KALAN | | | | 21.2 |
| 4 | AAQ-4 | DHABORA MUSTAKHAM | | | | 20.8 |
| 5 | AAQ-5 | BARKHERI | | 14.5 | 12 | 21.2 |
| 6 | AAQ-6 | BARKERA PANDE | 5 | | | 21.4 |
| 7 | AAQ-7 | NANDRAMPUR | | | | 20.6 |
| 8 | AAQ-8 | KHARAKPUR DEVIPURA | | | | 20.5 |
| 9 | AAQ-9 | KASHIPUR | 9 | | 12.5 | 22.1 |
| 10 | AAQ-10 | GANGAPUR GOSAIN | 6 | | | 21.5 |

**Table 9: SUMMARY OF AVERAGE VALUE OF OXIDES OF NITROGEN ($NO_x$) IN µg/$m^3$**

| SN | CODE | LOCATION | AVERAGE VALUE OF OXIDES OF NITROGEN (NOx) IN µg/m3 | | | |
|---|---|---|---|---|---|---|
| | | | 1998 | 2003 | 2010 | 2011 |
| 1 | AAQ-1 | ON SITE | 22 | 12 | | 12.1 |
| 2 | AAQ-2 | GINNI KHERA | | | | 11.3 |
| 3 | AAQ-3 | DHAKIA KALAN | | | | 12.4 |
| 4 | AAQ-4 | DHABORA MUSTAKHAM | | | | 12.7 |
| 5 | AAQ-5 | BARKHERI | | 14.5 | 12.5 | 13.5 |
| 6 | AAQ-6 | BARKERA PANDE | 11 | | | 11.4 |
| 7 | AAQ-7 | NANDRAMPUR | | | | 12.3 |
| 8 | AAQ-8 | KHARAKPUR DEVIPURA | | | | 11.5 |
| 9 | AAQ-9 | KASHIPUR | 16 | | 12.9 | 12.6 |
| 10 | AAQ-10 | GANGAPUR GOSAIN | 10 | | | 12.3 |

**Table 10: NOISE LEVEL DURING DAY TIME (2012)**

| Location | L Max | L Min | L eq. | L10 | L50 | L90 |
|---|---|---|---|---|---|---|
| N1 | 47.2 | 35.2 | 43.1 | 46.1 | 43.2 | 41.6 |
| N2 | 46.2 | 41.4 | 42.6 | 45.6 | 42.5 | 40.5 |
| N3 | 47.3 | 42.1 | 43.4 | 46.4 | 43.3 | 41.3 |
| N4 | 45.4 | 36.8 | 41.8 | 44.8 | 41.9 | 40.2 |
| N5 | 46.5 | 41.1 | 43.1 | 46.1 | 43.3 | 41.8 |
| N6 | 48.2 | 43.3 | 44.3 | 47.4 | 44.4 | 42.6 |
| N7 | 46.7 | 42.4 | 43.1 | 46.1 | 43.4 | 41.4 |
| N8 | 48.2 | 41.6 | 44.8 | 47.8 | 44.6 | 42.5 |
| N9 | 50.6 | 43.8 | 45.2 | 48.2 | 45.3 | 43.5 |
| N10 | 49.7 | 43.1 | 44.9 | 47.9 | 44.8 | 42.7 |

**Table 11: NOISE LEVEL DURING NIGHT TIME(2012)**

| Location | L Max | L Min | L eq. | L10 | L50 | L90 |
|---|---|---|---|---|---|---|
| N1 | 38.7 | 31.5 | 35.2 | 37.8 | 35.4 | 32.2 |
| N2 | 42.2 | 36.8 | 38.3 | 40.7 | 38.0 | 37.8 |
| N3 | 41.2 | 37.5 | 38.5 | 41.0 | 38.8 | 38.4 |
| N4 | 39.4 | 30.9 | 34.6 | 37.2 | 34.7 | 32.0 |
| N5 | 42.4 | 37.8 | 39.0 | 41.5 | 39.4 | 34.8 |
| N6 | 43.2 | 39.4 | 41.1 | 43.2 | 41.4 | 40.4 |
| N7 | 42.1 | 38.6 | 40.4 | 42.9 | 40.6 | 37.6 |
| N8 | 42.1 | 38.1 | 40.2 | 42.6 | 40.5 | 39.5 |
| N9 | 46.5 | 40.8 | 44.3 | 47.2 | 44.3 | 43.1 |
| N10 | 44.9 | 41.6 | 42.1 | 45.1 | 41.2 | 40.6 |

**Table 12: NOISE LEVEL DURING DAY TIME (2010)**

| Location | L Max | L Min | L eq. | L10 | L50 | L90 |
|---|---|---|---|---|---|---|
| N1 | 46.2 | 36.9 | 42.9 | 44.4 | 42.9 | 40.2 |
| N2 | | | | | | |
| N3 | | | | | | |
| N4 | | | | | | |
| N5 | 45.5 | 40.1 | 43.8 | 45.4 | 44 | 41.8 |
| N6 | | | | | | |
| N7 | | | | | | |
| N8 | | | | | | |
| N9 | 46.2 | 36.9 | 42.9 | 44.4 | 42.9 | 40.2 |
| N10 | | | | | | |

**Table 13: NOISE LEVEL DURING NIGHT TIME(2010)**

| Location | L Max | L Min | L eq. | L10 | L50 | L90 |
|---|---|---|---|---|---|---|
| N1 | 38.6 | 31.6 | 36.6 | 39 | 35.8 | 32.7 |
| N2 | | | | | | |
| N3 | | | | | | |
| N4 | | | | | | |
| N5 | 41.4 | 38 | 39.6 | 41.3 | 39.3 | 38 |
| N6 | | | | | | |
| N7 | | | | | | |
| N8 | | | | | | |
| N9 | 38.6 | 31.6 | 36.6 | 39 | 35.8 | 32.7 |
| N10 | | | | | | |

**Table 14: NOISE LEVEL DURING DAY TIME (2003)**

| Location | L Max | L Min | L eq. | L10 | L50 | L90 |
|---|---|---|---|---|---|---|
| N1 | 51.5 | 49.4 | 50 | | | |
| N2 | | | | | | |
| N3 | | | | | | |
| N4 | | | | | | |
| N5 | 46.2 | 39 | 42.6 | | | |
| N6 | | | | | | |
| N7 | | | | | | |
| N8 | | | | | | |
| N9 | 46.2 | 36.9 | 42.9 | 44.4 | 42.9 | 40.2 |
| N10 | | | | | | |

**Table 15: NOISE LEVEL DURING NIGHT TIME(2003)**

| Location | L Max | L Min | L eq. | L10 | L50 | L90 |
|---|---|---|---|---|---|---|
| N1 | | | | | | |
| N2 | | | | | | |
| N3 | | | | | | |
| N4 | | | | | | |
| N5 | | | | | | |
| N6 | | | | | | |
| N7 | | | | | | |
| N8 | | | | | | |
| N9 | 38.6 | 31.6 | 36.6 | 39 | 35.8 | 32.7 |
| N10 | | | | | | |

## TABLE 16: AVERAGE VALUE OF POLLUTANTS IN GROUND WATER OF STUDY AREA

| PARAMETER | UNIT | GW1 | | GW2 | GW3 | | | GW4 | | | GW5 | | | GW6 | GW7 | GW8 | | GW9 | | | GW10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2003 | 2011 | 2011 | 1998 | 2003 | 2011 | 1998 | 2003 | 2011 | 1998 | 2003 | 2011 | 2011 | 2011 | 2003 | 2011 | 1998 | 2010 | 2011 | 2011 |
| **pH** | - | 6.7 | 7.42 | 7.54 | 7.8 | 7.8 | 6.95 | 8 | 7.2 | 7.42 | 8.5 | 7 | 7.39 | 7.61 | 6.86 | 7 | 7.33 | 8 | 7.4 | 7.46 | 7.24 |
| **Color** | Hazen | | C.L. | C.L. | | | C.L. | | | C.L. | | | C.L. | C.L. | C.L. | | C.L. | | C/L | C.L. | C.L. |
| **Odour** | | | U.O.B | U.OB | | | U.OB | | | U.OB | | | U.OB | U.OB | U.OB | | U.OB | | U/O | U.OB | U.OB |
| **Taste** | | | AG | AG | | | AG | | | AG | | | AG | AG | AG | | AG | | | AG | AG |
| **Turbidity** | (NTU) | | 0.4 | 0.3 | | | 0.5 | | | 0.2 | | | 0.6 | 1.1 | 0.4 | | 0.4 | | 1 | 0.6 | 0.5 |
| **Total Hardness** | mg/l | 94.6 | 211 | 115 | 184 | 184 | 205 | 178 | 191 | 168 | 172 | 195 | 182 | 221 | 228 | 129 | 240 | 220 | 183 | 224 | 198 |
| **Ca Harness as CaCo3** | mg/l | 70 | 136 | 152 | 26 | 160 | 153 | 24 | 180 | 118 | 45 | 190 | 136 | 130 | 162 | 100 | 180 | 100 | | 131 | 141 |
| **Mg Hardness as CaCO3** | mg/l | 24.6 | 73 | 58 | 158 | 24 | 46 | 154 | 10.6 | 42 | 127 | 5.1 | 35 | 76 | 63 | 29 | 60 | 120 | | 79 | 57 |
| **Conductivity** | µð/cm | | 42.8 | 46.1 | | | 22 | | | 41.4 | | | 32.2 | 24.8 | 52.2 | | 45.1 | | 488 | 47.1 | 45.8 |
| **TDS** | mg/l | 234 | 378 | 370 | | 254 | 387 | | 482 | 330 | | 332 | 376 | 258 | 414 | | 315 | | 339. | 358 | 347 |
| **B.O.D.** | mg/l | | 1.5 | 2 | | | 2.2 | | | 1.8 | | | 2 | 1.6 | 2.5 | | 2.5 | | | 1.8 | 2 |
| **COD** | mg/l | | 52.8 | 41.1 | | | 25 | | | 38.4 | | | 26.2 | 18.8 | 36 | | 45.1 | | | 28.2 | 32.4 |
| **Chlorides as Cl ion** | mg/l | 14.2 | 28 | 15 | 9.3 | | 16 | 18.6 | 32.7 | 13 | 9.3 | 24.1 | 17 | 10 | 14 | 14.2 | 14 | 30 | 32 | 15 | 13 |
| **Fluride as F** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | 0.3 | ND | ND |
| **Calcium as Ca** | mg/l | 28 | 46 | 40 | 10.4 | 64 | 33 | 9.6 | 72 | 28 | 18 | 76 | 38 | 42 | 52 | 40 | 37 | 40 | 40.3 | 35 | 27 |
| **Magnesium as Mg** | mg/l | 6 | 18 | 16 | 38 | 5.8 | 12 | 37 | 2.6 | 20 | 31 | 1.2 | 11 | 14 | 25 | 7.1 | 14 | 29 | 20 | 16 | 14 |
| **Sulphates as SO4-** | mg/l | 7 | 12 | 21.5 | 25 | 25 | 9 | 18 | 58.1 | 7.2 | 7 | 20.6 | 15.2 | 17.8 | 10.2 | 1.7 | 14.4 | 11 | 30 | 20.4 | 18.2 |
| **Nitrates as NO3** | mg/l | | 0.25 | 0.32 | | | 0.19 | | | 0.17 | | | 0.23 | 0.13 | 0.26 | | 0.15 | | 4.4 | 0.28 | 0.16 |

## TABLE 17: AVERAGE VALUE OF POLLUTANTS IN GROUND WATER OF STUDY AREA

| PARAMETER | UNIT | GW1 | | GW2 | GW3 | | | GW4 | | | GW5 | | | GW6 | GW7 | GW8 | | GW9 | | | GW10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2003 | 2011 | 2011 | 1998 | 2003 | 2011 | 1998 | 2003 | 2011 | 1998 | 2003 | 2011 | 2011 | 2011 | 2003 | 2011 | 1998 | 2010 | 2011 | 2011 |
| **Total Nitrogen** | mg/l | | 0.28 | 0.13 | | | 0.11 | | | 0.16 | | | 0.26 | 0.2 | 0.27 | | 0.17 | | | 0.12 | 0.14 |
| **Total Phosphorus** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | | ND | ND |
| **Phenolics as C6H5OH** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | <5e-4 | ND | ND |
| **Alkalinity as CaCO3** | mg/l | | 172 | 122 | 178 | 178 | 136 | 218 | 844 | 132 | 196 | 680 | 143 | 142 | 121 | 580 | 140 | 216 | 162 | 135 | 141 |
| **Boron** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | | ND | ND |
| **Sodium as Na** | mg/l | 16.3 | 31.6 | 37.2 | 10.15 | 18.9 | 24.7 | 28.4 | 42.3 | 30.8 | 15.6 | 24.3 | 36.3 | 38.6 | 23.7 | 24.8 | 30.8 | 20.8 | 8.9 | 27.9 | 30.7 |
| **Potassium as K** | mg/l | 3.3 | 22.2 | 16.4 | 1.86 | 2.5 | 19.8 | 2.09 | 4.2 | 26.6 | 2.86 | 5.6 | 23 | 28.1 | 20.6 | 5.1 | 23.7 | 2.23 | 6 | 21.3 | 26.4 |
| **Iron as Fe** | mg/l | | 0.07 | 0.15 | 0.9 | 0.7 | 0.16 | 0.9 | 1 | 0.12 | 0.1 | 0.7 | 0.13 | 0.13 | 0.08 | 0.9 | 0.1 | 0.4 | 0.081 | 0.18 | 0.15 |
| **Copper as Cu** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | <0.03 | ND | ND |
| **Manganese as Mn** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | <0.02 | ND | ND |
| **Aluminum as Al** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | | ND | ND |
| **Selenum as Se** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | | ND | ND |
| **Arsenic as As** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | <0.01 | ND | ND |
| **Zinc as Zn** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | 1 | ND | ND |
| **Mineral Oil** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | | ND | ND |
| **Pesticides** | mg/l | | ND | ND | | | ND | | | ND | | | ND | ND | ND | | ND | | | ND | ND |
| **Total Coliforms** | MPN/100ml | | Nil | Nil | | | Nil | | | Nil | | | Nil | Nil | Nil | | Nil | | | Nil | Nil |

## TABLE 18: AVERAGE VALUE OF POLLUTANTS IN GROUND WATER (2011)

| S. No | Parameter | Unit | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | GW7 | GW8 | GW9 | GW10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A-1 industrial area | Ginni khera | Dhakia kalan | Dhabora mustakham | Barkheri | Barkera pande | Nand Rampur | Kharakpur Devipura | Kashipur | Gangapur gosain |
| 1. | pH | - | 7.42 | 7.54 | 6.95 | 7.42 | 7.39 | 7.61 | 6.86 | 7.33 | 7.46 | 7.24 |
| 2. | Color | Hazen | C.L. | C.L. | C.L. | C.L. | C.L. | C.L. | C.L. | C.L. | C.L. | C.L. |
| 3. | Conductivity | µð/cm | 42.8 | 46.1 | 22 | 41.4 | 32.2 | 24.8 | 52.2 | 45.1 | 47.1 | 45.8 |
| 4. | Total Coliform | MPN/100 ml | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil |
| 5. | B.O.D. (3days at 27 degC) | mg/l | 1.5 | 2 | 2.2 | 1.8 | 2 | 1.6 | 2.5 | 2.5 | 1.8 | 2 |
| 6. | COD | mg/l | 52.8 | 41.1 | 25 | 38.4 | 26.2 | 18.8 | 36 | 45.1 | 28.2 | 32.4 |
| 7. | Total Dissolved Solids | mg/l | 378 | 370 | 387 | 330 | 376 | 258 | 414 | 315 | 358 | 347 |
| 8. | Turbidity | NTU | 0.4 | 0.3 | 0.5 | 0.2 | 0.6 | 1.1 | 0.4 | 0.4 | 0.6 | 0.5 |
| 9. | Total Alkalinity as CaCO3 | mg/l | 172 | 122 | 136 | 132 | 143 | 142 | 121 | 140 | 135 | 141 |
| 10. | Total Hardness as CaCO3 | mg/l | 211 | 115 | 205 | 168 | 182 | 221 | 228 | 240 | 224 | 198 |
| 11. | Calcium Harness as CaCO3 | mg/l | 136 | 152 | 153 | 118 | 136 | 130 | 162 | 180 | 131 | 141 |

| S. No | Parameter | Unit | GW1 | GW2 | GW3 | GW4 | GW5 | GW6 | GW7 | GW8 | GW9 | GW10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | A-1 industrial area | Ginni khera | Dhakia kalan | Dhabora mustakham | Barkheri | Barkera pande | Nand Rampur | Kharakpur Devipura | Kashipur | Gangapur gosain |
| 12. | Chlorides as Cl ion | mg/l | 28 | 15 | 16 | 13 | 17 | 10 | 14 | 14 | 15 | 13 |
| 13. | Sulphates as SO4- | mg/l | 12 | 21.5 | 9 | 7.2 | 15.2 | 17.8 | 10.2 | 14.4 | 20.4 | 18.2 |
| 14. | Nitrates as NO3 | mg/l | 0.25 | 0.32 | 0.19 | 0.17 | 0.23 | 0.13 | 0.26 | 0.15 | 0.28 | 0.16 |
| 15. | Sodium | mg/l | 31.6 | 37.2 | 24.7 | 30.8 | 36.3 | 38.6 | 23.7 | 30.8 | 27.9 | 30.7 |
| 16. | Potassium | mg/l | 22.2 | 16.4 | 19.8 | 26.6 | 23 | 28.1 | 20.6 | 23.7 | 21.3 | 26.4 |
| 17. | Iron as Fe | mg/l | 0.07 | 0.15 | 0.16 | 0.12 | 0.13 | 0.13 | 0.08 | 0.1 | 0.18 | 0.15 |
| 18. | Fluoride as F | mg/l | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| 19. | Zinc as Zn | mg/l | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |

## TABLE 19: AVERAGE VALUE OF POLLUTANTS IN SURFACE WATER (2011)

| S. No | Parameter | Unit | Bahella River (U/S) | Bahella River (D/S) | Mahadev Stream | Kosi River (U/S) | Kosi River (D/S) | Khokratal |
|---|---|---|---|---|---|---|---|---|
| 1. | pH | - | 7.85 | 8 | 7.48 | 7.52 | 7.48 | 7.65 |
| 2. | Temperature | Deg C | 20 | 18 | 19 | 17 | 19 | 18 |
| 3. | Color | Hazen | C.L. | C.L. | C.L. | C.L. | C.L. | Light yellow |
| 4. | Conductivity | µð/cm | 624 | - | 464 | 522 | - | 532 |
| 5. | Dissolved Oxygen | mg/l | 3 | - | 5 | 4 | - | 2.8 |
| 6. | Total Coliform | MPN/100 ml | 32 | 36 | 38 | 28 | 34 | 54 |
| 7. | B.O.D. (3days at 27 degC) | mg/l | 4 | 8 | 3 | 2 | 8 | 6 |
| 8. | COD | mg/l | 16.2 | 18 | 14 | 8 | 18 | 24.4 |
| 9. | Total Dissolved Solids | mg/l | 488 | 385 | 352 | 337 | 385 | 393 |
| 10. | Total Suspended Solids | mg/l | 252 | 56 | 114 | 119 | 56 | 147 |
| 11. | Turbidity | NTU | 4 | 2.2 | 3 | 4.2 | 3 | 4.8 |

| S. No | Parameter | Unit | Bahella River (U/S) | Bahella River (D/S) | Mahadev Stream | Kosi River (U/S) | Kosi River (D/S) | Khokratal |
|---|---|---|---|---|---|---|---|---|
| 12. | Total Hardness as CaCO3 | mg/l | 373 | 288 | 383 | 353 | 288 | 478 |
| 13. | Total Alkalinity as CaCO3 | mg/l | 158 | 302 | 155 | 157 | 302 | 190 |
| 14. | Chlorides as Cl | mg/l | 16 | 32 | 14 | 14 | 32 | 56 |
| 15. | Sodium | mg/l | 41.4 | - | 39.1 | 35.5 | - | 33.6 |
| 16. | Potassium | mg/l | 18.1 | - | 16.6 | 20.7 | - | 19.3 |
| 17. | Iron as Fe | mg/l | 0.46 | 0.12 | 0.33 | 0.35 | 0.12 | 0.54 |
| 18. | Zinc as Zn | mg/l | 0.025 | - | 0.021 | 0.019 | - | 0.038 |

**TABLE 20: COMPREHENSIVE VALUE OF CONDUCTIVITY IN SURFACE WATER IN BETWEEN 1998 & 2011**

| S. No | LOCATION | Comprehensive value of Conductivity (µδ/cm ) | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 1. | BAHELLA U/S | | | 216 | 624 |
| 2. | BAHELLA D/S | | | | 453 |
| 3. | MAHADEV STREAM | | | | 464 |
| 4. | KOSHI RIVER U/S | | | 174 | 522 |
| 5. | KOSHI RIVER D/S | | | | 464 |
| 6. | KHOKRATAL | | | | 532 |

**TABLE 21: COMPREHENSIVE VALUE OF TDS IN SURFACE WATER IN BETWEEN 1998 & 2011**

| S. No | LOCATION | Comprehensive value of TDS (mg/l) | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 7. | BAHELLA U/S | | | 153 | 488 |
| 8. | BAHELLA D/S | | | | 347 |
| 9. | MAHADEV STREAM | | | | 352 |
| 10. | KOSHI RIVER U/S | 356 | 325 | 140 | 337 |
| 11. | KOSHI RIVER D/S | 385 | | | 357 |
| 12. | KHOKRATAL | | | | 393 |

## TABLE 22: COMPREHENSIVE VALUE OF BOD IN SURFACE WATER IN BETWEEN 1998 & 2011

| S. No | LOCATION | Comprehensive value of BOD (mg/l) | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 13. | BAHELLA U/S | | | 1.3 | 4 |
| 14. | BAHELLA D/S | | | | 2 |
| 15. | MAHADEV STREAM | | | | 3 |
| 16. | KOSHI RIVER U/S | 5.6 | 4.6 | 1 | 2 |
| 17. | KOSHI RIVER D/S | 8 | | | 3 |
| 18. | KHOKRATAL | | | | 6 |

**TABLE 23: COMPREHENSIVE VALUE OF COD IN SURFACE WATER IN BETWEEN 1998 & 2011**

| S. No | LOCATION | Comprehensive value of COD (mg/l) | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 19. | BAHELLA U/S | | | 8 | 16.2 |
| 20. | BAHELLA D/S | | | | 15 |
| 21. | MAHADEV STREAM | | | | 14 |
| 22. | KOSHI RIVER U/S | 8 | 14 | 8.9 | 8 |
| 23. | KOSHI RIVER D/S | 18 | | | 14 |
| 24. | KHOKRATAL | | | | 24.4 |

**TABLE 24: COMPREHENSIVE VALUE OF TOTAL HARDNESS IN SURFACE WATER IN BETWEEN 1998 & 2011**

| S. No | LOCATION | Comprehensive value of Total Hardness as $CaCO_3$ (mg/l) | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 25. | BAHELLA U/S | | | 80 | 373 |
| 26. | BAHELLA D/S | | | | 364 |
| 27. | MAHADEV STREAM | | | | 383 |
| 28. | KOSHI RIVER U/S | 251 | 251 | 68 | 353 |
| 29. | KOSHI RIVER D/S | 288 | | | 383 |
| 30. | KHOKRATAL | | | | 478 |

**TABLE 25: COMPREHENSIVE VALUE OF ALKALINITY AS $CACO_3$ IN SURFACE WATER IN BETWEEN 1998 & 2011**

| S. No | LOCATION | Comprehensive value of Alkalinity as $CaCO_3$ (mg/l) | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 31. | BAHELLA U/S | | | 52 | 158 |
| 32. | BAHELLA D/S | | | | 143 |
| 33. | MAHADEV STREAM | | | | 155 |
| 34. | KOSHI RIVER U/S | 278 | 278 | 52 | 157 |
| 35. | KOSHI RIVER D/S | 302 | | | 165 |
| 36. | KHOKRATAL | | | | 190 |

## TABLE 26: COMPREHENSIVE VALUE OF CHLORIDE IN SURFACE WATER IN BETWEEN 1998 & 2011

| S. No | LOCATION | Comprehensive value of Chlorides as Cl (mg/l) | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 37. | BAHELLA U/S | | | 20 | 16 |
| 38. | BAHELLA D/S | | | | 12 |
| 39. | MAHADEV STREAM | | | | 14 |
| 40. | KOSHI RIVER U/S | 20 | | 14 | 14 |
| 41. | KOSHI RIVER D/S | 32 | | | 21 |
| 42. | KHOKRATAL | | | | 25 |

## TABLE 27: COMPREHENSIVE VALUE OF NITRATES IN SURFACE WATER IN BETWEEN 1998 & 2011

| S. No | LOCATION | Comprehensive value of Nitrates as NO3 (mg/l) | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 43. | BAHELLA U/S | | | 5.8 | 16 |
| 44. | BAHELLA D/S | | | | 26 |
| 45. | MAHADEV STREAM | | | | 24 |
| 46. | KOSHI RIVER U/S | | | 6.2 | 23 |
| 47. | KOSHI RIVER D/S | | | | 25 |
| 48. | KHOKRATAL | | | | 32.5 |

**TABLE 28: COMPREHENSIVE VALUE OF SULFATES IN SURFACE WATER IN BETWEEN 1998 & 2011**

| S. No | LOCATION | Comprehensive value of Sulfates as $SO_4$ as (mg/l) | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 49. | BAHELLA U/S | | | 27 | 17.7 |
| 50. | BAHELLA D/S | | | | 19.2 |
| 51. | MAHADEV STREAM | | | | 20.6 |
| 52. | KOSHI RIVER U/S | 285 | 74 | 24 | 18.8 |
| 53. | KOSHI RIVER D/S | 260 | | | 20.2 |
| 54. | KHOKRATAL | | | | 25.3 |

## TABLE 29: COMPREHENSIVE VALUE OF TURBIDITY IN SURFACE WATER IN BETWEEN 1998 & 2011

| S. No | LOCATION | Comprehensive value of Turbidity (NTU) | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 55. | BAHELLA U/S | | | 8 | 4 |
| 56. | BAHELLA D/S | | | | 2.2 |
| 57. | MAHADEV STREAM | | | | 3 |
| 58. | KOSHI RIVER U/S | | | 6 | 4.2 |
| 59. | KOSHI RIVER D/S | | | | 3 |
| 60. | KHOKRATAL | | | | 4.8 |

**TABLE 30: COMPREHENSIVE VALUE OF pH IN SURFACE WATER IN BETWEEN 1998 & 2011**

| S. No | LOCATION | Comprehensive value of pH | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 61. | BAHELLA U/S | | | 7.1 | 7.85 |
| 62. | BAHELLA D/S | | | | 7.55 |
| 63. | MAHADEV STREAM | | | | 7.48 |
| 64. | KOSHI RIVER U/S | 7.8 | 7.9 | 7.4 | 7.52 |
| 65. | KOSHI RIVER D/S | 8 | | | 7.48 |
| 66. | KHOKRATAL | | | | 7.65 |

**TABLE 31: AVERAGE VALUE OF MONITORING PARAMETER IN SOIL(2011)**

| Parameter | Unit | S-1 | S-2 | S-3 | S-4 | S-5 | S-6 | S-7 | S-8 | S-9 | S-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH (1:5 Aq.Extract) | | 7.4 | 7.7 | 7.3 | 7.8 | 7.1 | 7.4 | 7.5 | 7.2 | 7.4 | 7.3 |
| Conductivity (1:5 Aq.Extract) | µS/cm | 468 | 495 | 960 | 367 | 283 | 465 | 386 | 263 | 346 | 940 |
| Moisture Content | % | 40 | 51 | 47 | 50 | 46 | 49 | 40 | 44 | 43 | 43 |
| Texture | - | Silty Loam | Loam | Clay | Clay | Clay | Clay | Clay | Clay | Clay | Clay |
| Sand | % | 5.0 | 3.4 | 4.8 | 2.9 | 5.0 | 15.0 | 5.0 | 4.8 | 5.2 | 4.7 |
| Silt | % | 35.0 | 30.6 | 30.2 | 30.1 | 32.0 | 33.0 | 30.0 | 33.0 | 31.0 | 34.2 |
| Clay | % | 60.0 | 66.0 | 65.0 | 67.0 | 63.0 | 52.0 | 60.0 | 63.0 | 61.0 | 64.0 |
| Bulk Density | g/cc | 1.24 | 1.23 | 1.29 | 1.12 | 1.36 | 1.09 | 1.28 | 1.26 | 1.38 | 1.27 |
| Cation Exchange Capacity | m.eq/100 g | 30.20 | 25.99 | 32.64 | 26.15 | 17.25 | 31.51 | 34.31 | 19.25 | 31.31 | 31.44 |
| Exchangeable Calcium as Ca | mg/kg | 12.8 | 9.4 | 10.2 | 8.6 | 6.6 | 12.3 | 24.1 | 6.3 | 14.1 | 11.2 |
| Exchangeable Magnesium as Mg | mg/kg | 4.4 | 7.5 | 3.2 | 6.9 | 6.4 | 5.8 | 21.0 | 5.4 | 21.0 | 3.3 |

| Parameter | Unit | S-1 | S-2 | S-3 | S-4 | S-5 | S-6 | S-7 | S-8 | S-9 | S-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Exchangeable Sodium as Na | mg/kg | 3.5 | 4.4 | 5.8 | 5.0 | 6.8 | 5.7 | 4.8 | 6.5 | 4.4 | 5.2 |
| Available Potassium as K | mg/kg | 68 | 87 | 168 | 143 | 88 | 71 | 154 | 89 | 164 | 158 |
| Available Phosphorus as P | Mg/kg | 52.3 | 24.8 | 30.4 | 16.7 | 24.7 | 18.2 | 24.7 | 25.6 | 24.4 | 31.4 |
| Available Nitrogen as N | Mg/kg | 285.7 | 274.8 | 256.0 | 308.5 | 291.1 | 315.5 | 302.6 | 280.0 | 296.6 | 275.0 |
| Organic Carbon | % | 0.08 | 0.21 | 0.14 | 0.14 | 0.21 | 0.14 | 0.21 | 0.23 | 0.19 | 0.16 |
| Organic Matter | % | 3.37 | 5.43 | 4.76 | 4.98 | 6.13 | 4.12 | 5.36 | 6.15 | 5.26 | 4.55 |
| Water Holding Capacity, | % w/w | 39.2 | 40.6 | 43.0 | 38.7 | 42.5 | 38.4 | 36.6 | 41.9 | 35.3 | 41.2 |
| Porosity, | % w/w | 42.4 | 44.6 | 48.6 | 45.1 | 43.5 | 47.5 | 44.2 | 43.3 | 42.8 | 47.7 |
| Water Soluble Chlorides as Cl | Mg/kg | 23 | 16 | 12 | 13 | 17 | 12 | 13 | 16 | 14 | 15 |
| Water Soluble Sulphates as $SO_4$ | Mg/kg | 16.6 | 12.2 | 22.3 | 26.4 | 19.8 | 21.6 | 23.0 | 18.8 | 22.6 | 22.1 |
| Sodium Absorption Ratio | m mole/l | 2.13 | 1.70 | 2.72 | 1.97 | 2.02 | 3.07 | 2.49 | 1.90 | 2.22 | 2.67 |

**TABLE 32: COMPREHENSIVE ACCOUNT OF SOIL QUALITY OF STUDY AREA IN BETWEEN 1998 TO 2011**

| S. No | LOCATION | Comprehensive value of pH 1.5 Aq. Extract | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 1. | On Site | | | | 7.4 |
| 2. | Ginni khera | | | | |
| 3. | Dhakia kalan | 7.5 | | | 7.3 |
| 4. | Dhabora mustakham | | | | 7.8 |
| 5. | Barkheri | 7 | | | 7.1 |
| 6. | Barkera pande | 7 | | | 7.4 |
| 7. | Nandrampur | 7.5 | | | 7.5 |
| 8. | Kharakpur devipura | 7.5 | | | 7.2 |
| 9. | Kashipur | | | | 7.4 |
| 10. | Gangapur Gosain | | | | 7.3 |

**TABLE 33: COMPREHENSIVE ACCOUNT OF SOIL QUALITY OF STUDY AREA IN BETWEEN 1998 TO 2011**

| S. No | LOCATION | Comprehensive value of Conductivity (1:5 Aq. Extract) in µs/cm | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 1. | On Site | | | | 468 |
| 2. | Ginni khera | | | | 0 |
| 3. | Dhakia kalan | | | | 960 |
| 4. | Dhabora mustakham | | | | 367 |
| 5. | Barkheri | | | | 283 |
| 6. | Barkera pande | | | | 465 |
| 7. | Nandrampur | | | | 386 |
| 8. | Kharakpur devipura | | | | 263 |
| 9. | Kashipur | | | | 346 |
| 10. | Gangapur Gosain | | | | 940 |

**TABLE 34: COMPREHENSIVE ACCOUNT OF SOIL QUALITY OF STUDY AREA IN BETWEEN 1998 TO 2011**

| S. No | LOCATION | Comprehensive value of Exchangeable Calcium as Ca in mg/kg | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 1. | On Site | | | | 12.8 |
| 2. | Ginni khera | | | | |
| 3. | Dhakia kalan | 1.2 | | | 10.2 |
| 4. | Dhabora mustakham | | | | 8.6 |
| 5. | Barkheri | 1.0 | | | 6.6 |
| 6. | Barkera pande | 0.4 | | | 12.3 |
| 7. | Nandrampur | 0.8 | | | 24.1 |
| 8. | Kharakpur devipura | 1.0 | | | 24.1 |
| 9. | Kashipur | | | | 14.1 |
| 10. | Gangapur Gosain | | | | 11.2 |

**TABLE 35: COMPREHENSIVE ACCOUNT OF SOIL QUALITY OF STUDY AREA IN BETWEEN 1998 TO 2011**

| S. No | LOCATION | Comprehensive value of Exchangeable Sodium as Na in mg/kg | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 1. | On Site | | | | 3.5 |
| 2. | Ginni khera | | | | |
| 3. | Dhakia kalan | 0.51 | | | 5.8 |
| 4. | Dhabora mustakham | | | | 5 |
| 5. | Barkheri | 0.51 | | | 6.8 |
| 6. | Barkera pande | 0.64 | | | 5.7 |
| 7. | Nandrampur | 0.35 | | | 4.8 |
| 8. | Kharakpur devipura | 0.48 | | | 4.8 |
| 9. | Kashipur | | | | 4.4 |
| 10. | Gangapur Gosain | | | | 5.2 |

**TABLE 36: COMPREHENSIVE ACCOUNT OF SOIL QUALITY OF STUDY AREA IN BETWEEN 1998 TO 2011**

| S. No | LOCATION | Comprehensive value of Available Potassium as K in mg/kg | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 1. | On Site | | | | 68 |
| 2. | Ginni khera | | | | |
| 3. | Dhakia kalan | | | | 168 |
| 4. | Dhabora mustakham | | | | 143 |
| 5. | Barkheri | | | | 88 |
| 6. | Barkera pande | | | | 71 |
| 7. | Nandrampur | | | | 154 |
| 8. | Kharakpur devipura | | | | 154 |
| 9. | Kashipur | | | | 164 |
| 10. | Gangapur Gosain | | | | 158 |

**TABLE 37: COMPREHENSIVE ACCOUNT OF SOIL QUALITY OF STUDY AREA IN BETWEEN 1998 TO 2011**

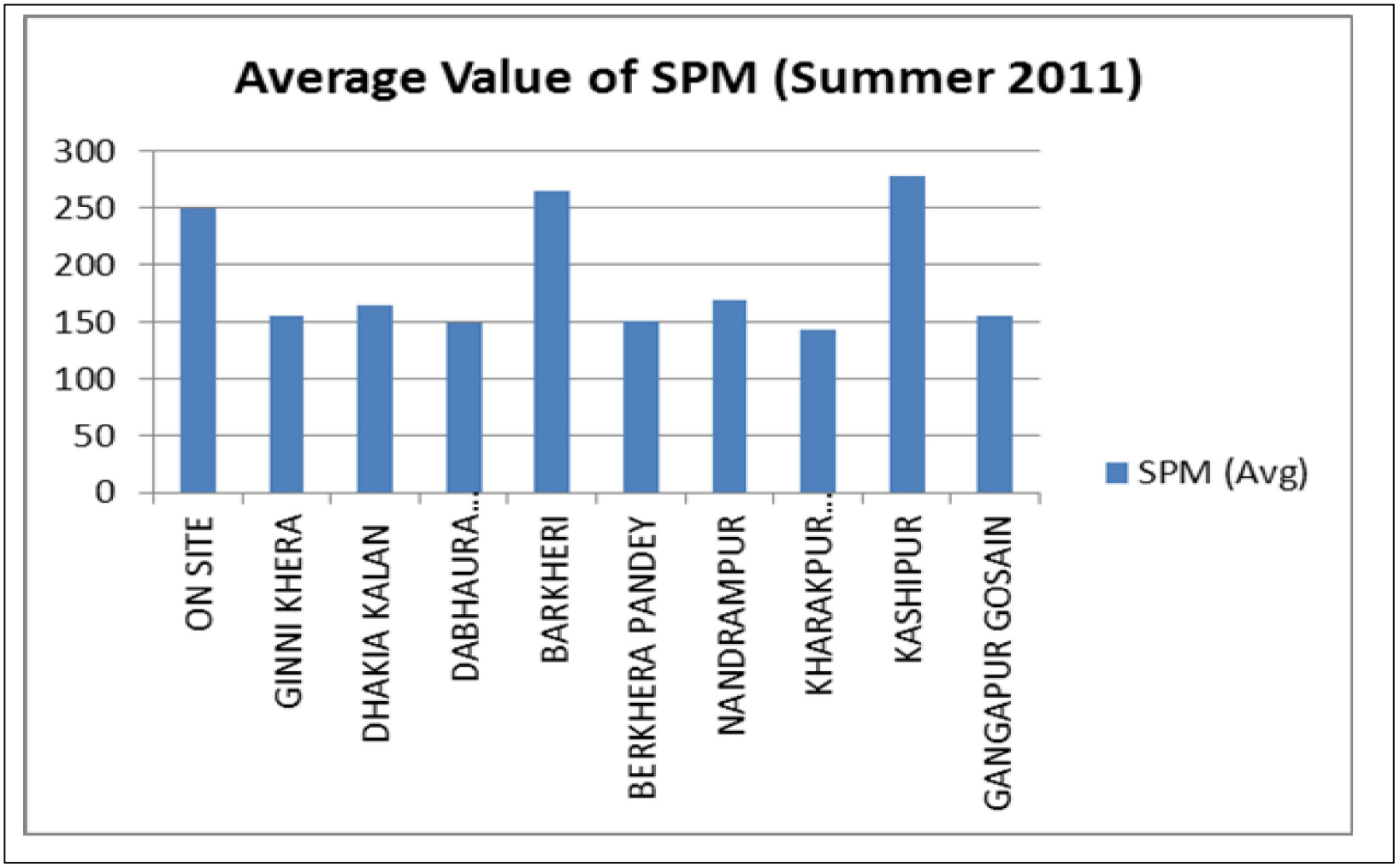
| S. No | LOCATION | Comprehensive value of Water Soluble Chlorides as Cl in mg/kg | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 1. | On Site | | | | 23 |
| 2. | Ginni khera | | | | |
| 3. | Dhakia kalan | | | | 12 |
| 4. | Dhabora mustakham | | | | 13 |
| 5. | Barkheri | | | | 17 |
| 6. | Barkera pande | | | | 12 |
| 7. | Nandrampur | | | | 13 |
| 8. | Kharakpur devipura | | | | 13 |
| 9. | Kashipur | | | | 14 |
| 10. | Gangapur Gosain | | | | 15 |

**TABLE 38: COMPREHENSIVE ACCOUNT OF SOIL QUALITY OF STUDY AREA IN BETWEEN 1998 TO 2011**

| S. No | LOCATION | Comprehensive value of Water Soluble Sulphates as SO4 in mg/kg | | | |
|---|---|---|---|---|---|
| | | 1998 | 2003 | 2010 | 2011 |
| 1. | On Site | | | | 16.6 |
| 2. | Ginni khera | | | | |
| 3. | Dhakia kalan | 1.9 | | | 22.3 |
| 4. | Dhabora mustakham | | | | 26.4 |
| 5. | Barkheri | 1.17 | | | 19.8 |
| 6. | Barkera pande | 1.8 | | | 21.6 |
| 7. | Nandrampur | 1.4 | | | 23 |
| 8. | Kharakpur devipura | 2.3 | | | 23 |
| 9. | Kashipur | | | | 22.6 |
| 10. | Gangapur Gosain | | | | 22.1 |

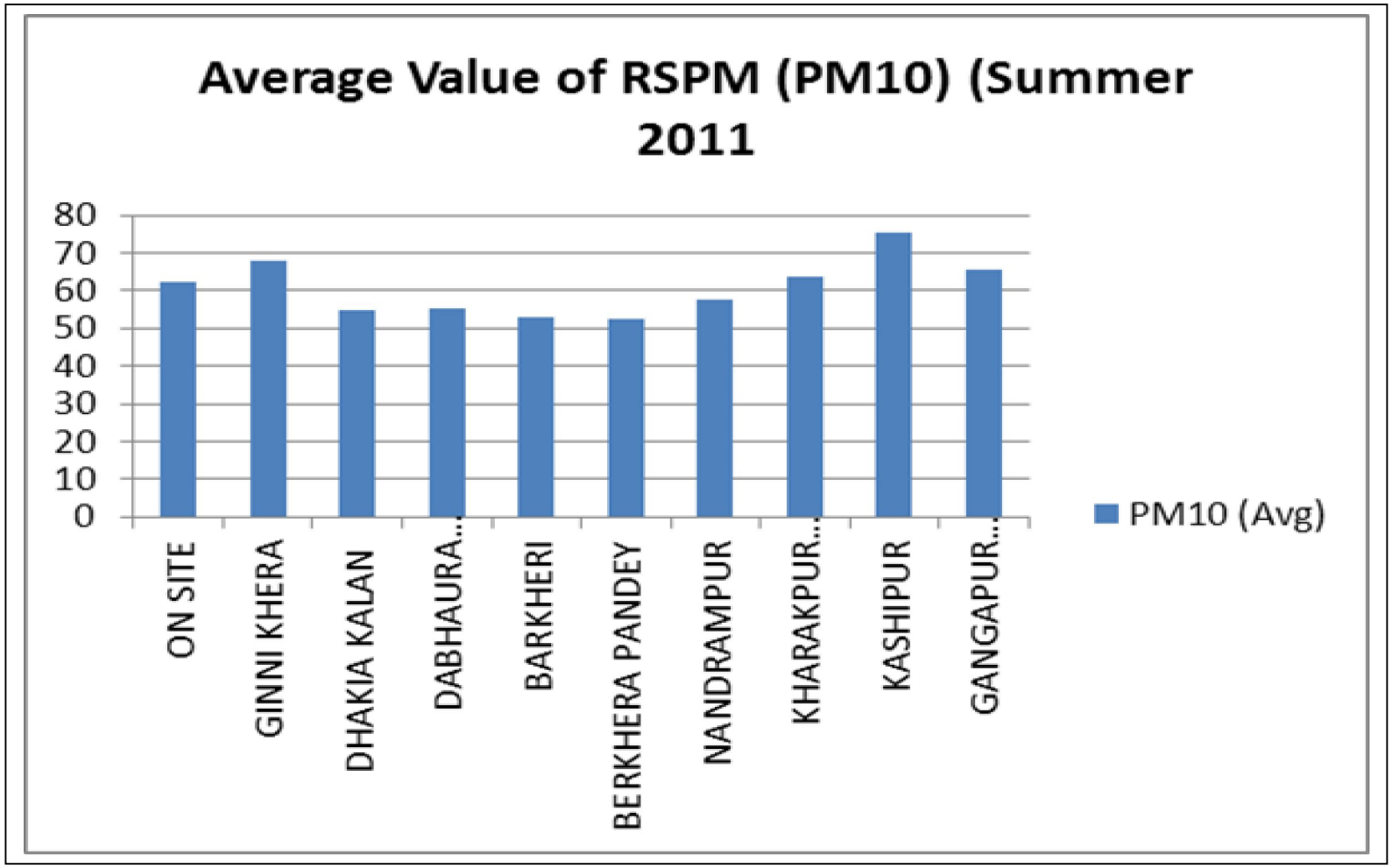
## GRAPH

**FIGURE 1: AVERAGE VALUE OF SPM IN (SUMMER 2011)**



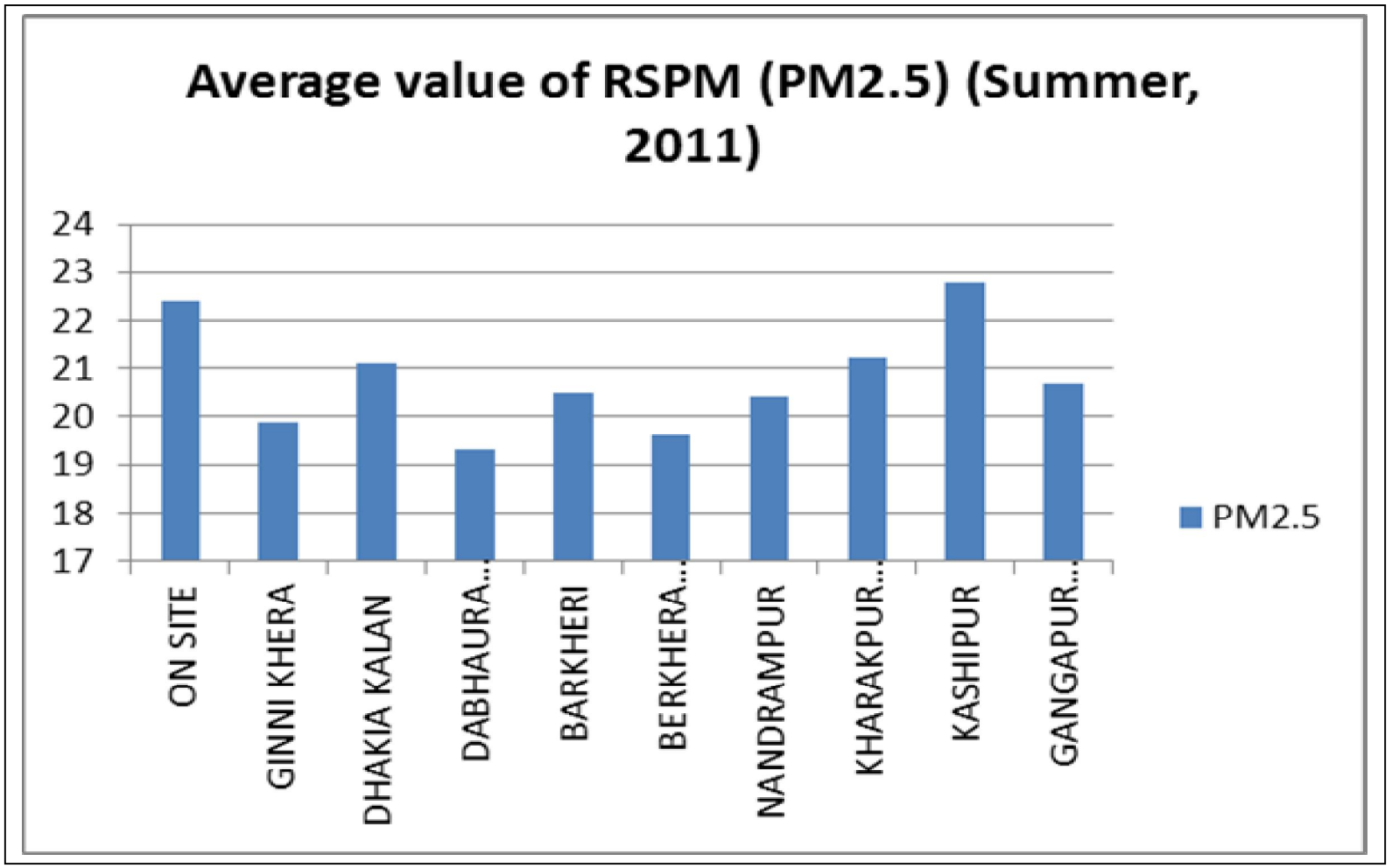

Average Value of SPM in (Summer 2011)

**FIGURE 2: AVERAGE VALUE OF PM10 IN (SUMMER 2011)**



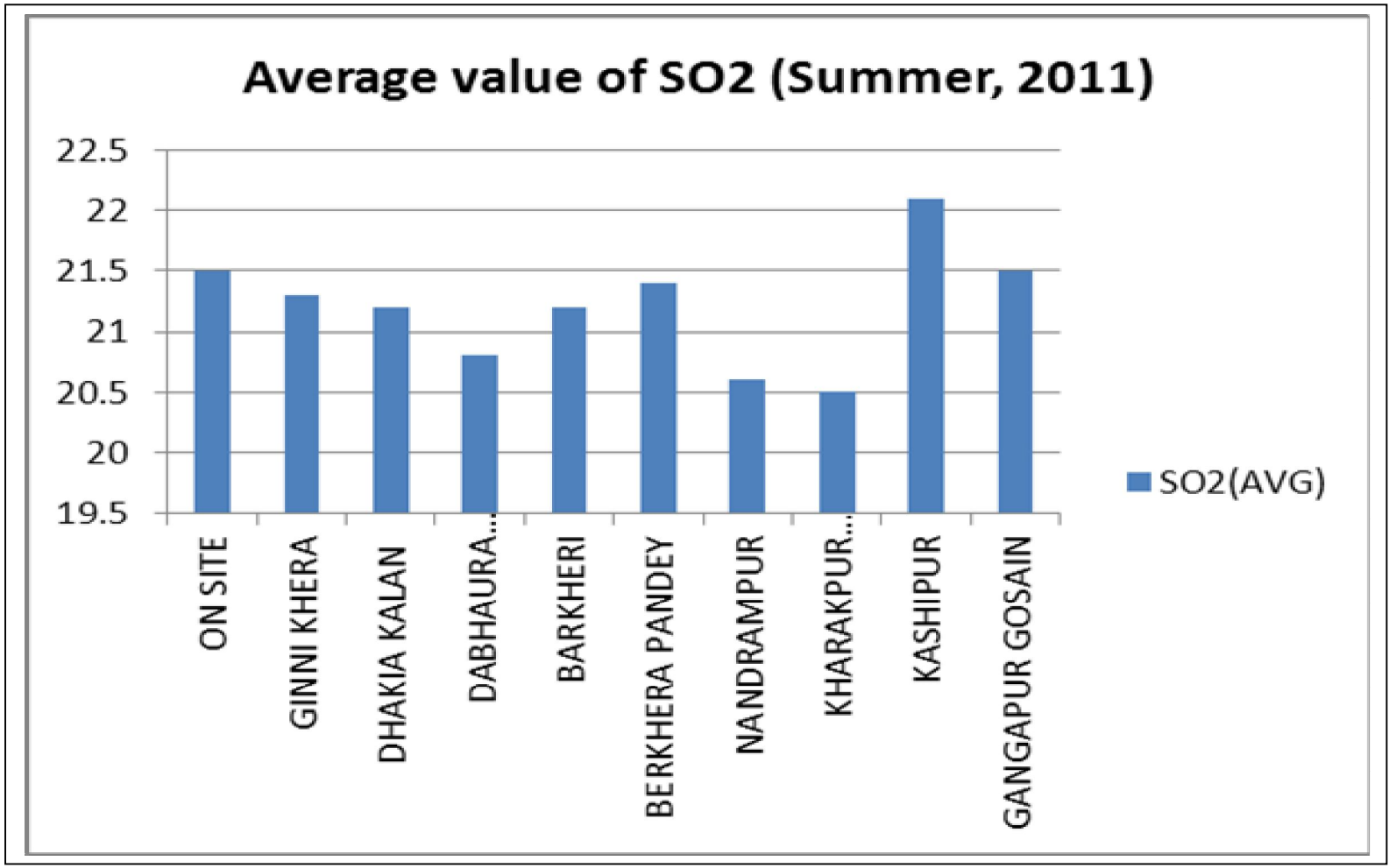

Average Value of PM10 in (Summer 2011)

**FIGURE 3: AVERAGE VALUE OF PM2.5 IN (SUMMER 2011)**



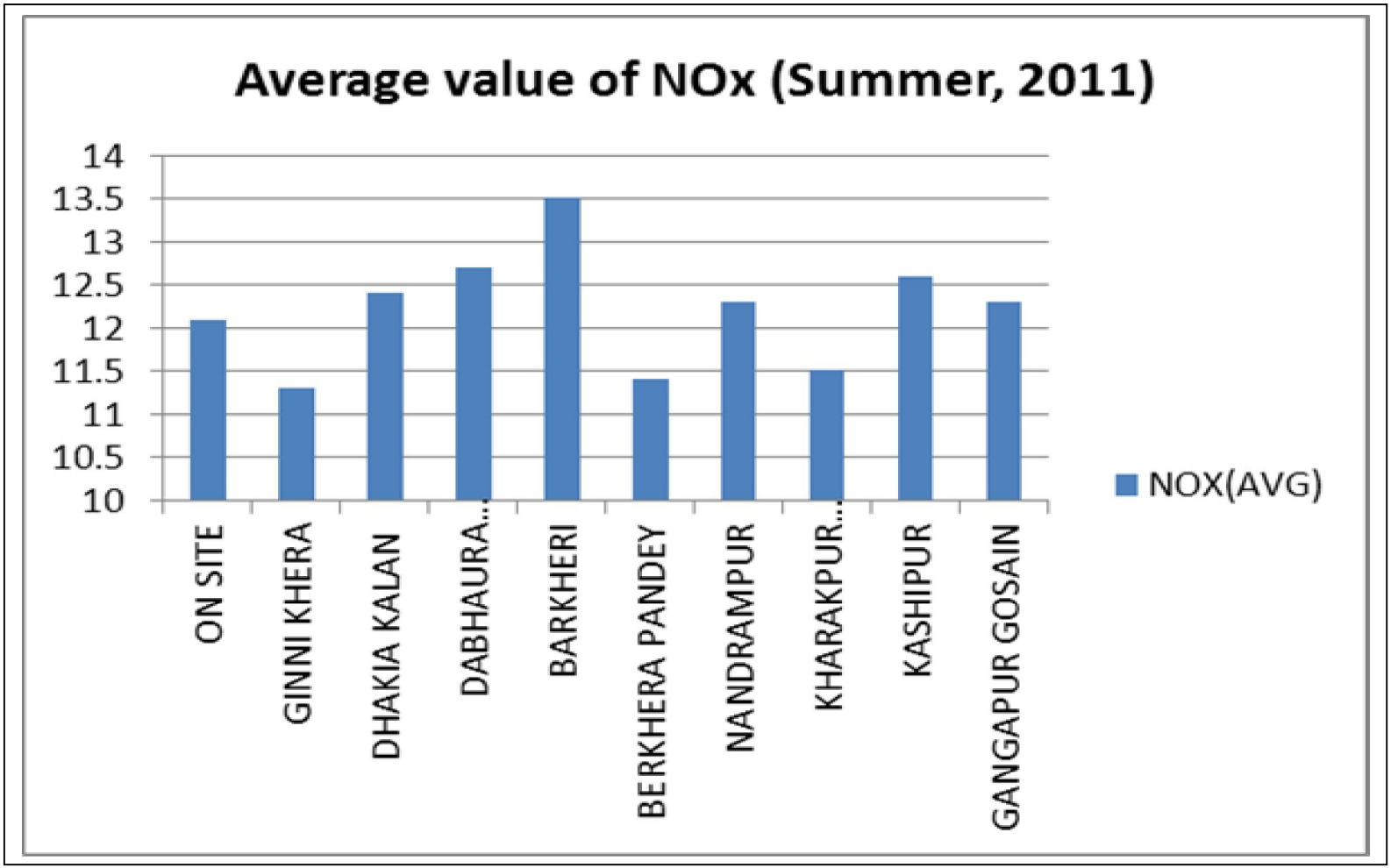

Average Value of PM2.5 in (Summer 2011)

**FIGURE 4: AVERAGE VALUE OF $SO_2$ IN (SUMMER 2011)**



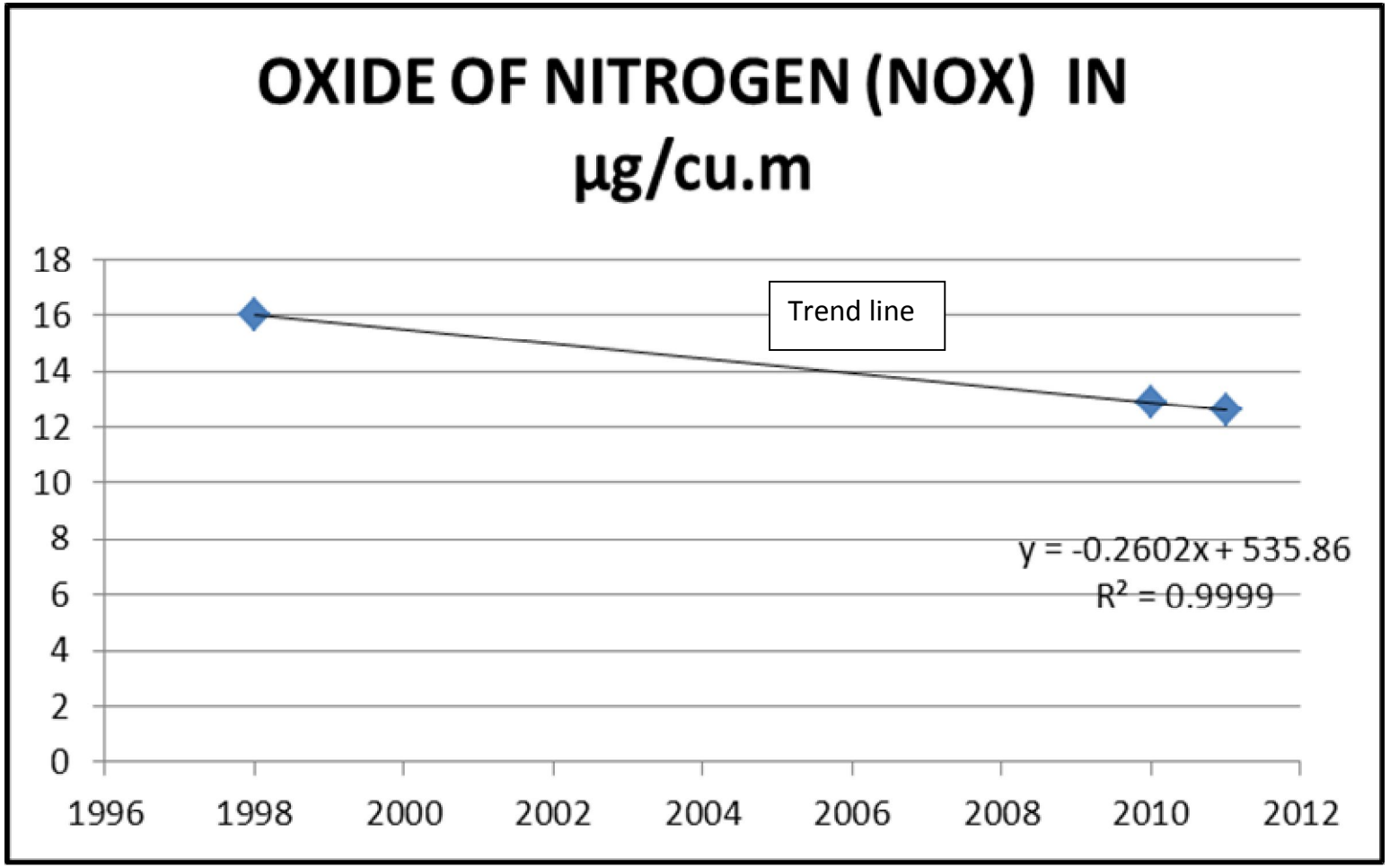

Average Value of $SO_2$ in (Summer 2011)

**FIGURE 5: AVERAGE VALUE OF $NO_X$ IN (SUMMER 2011)**



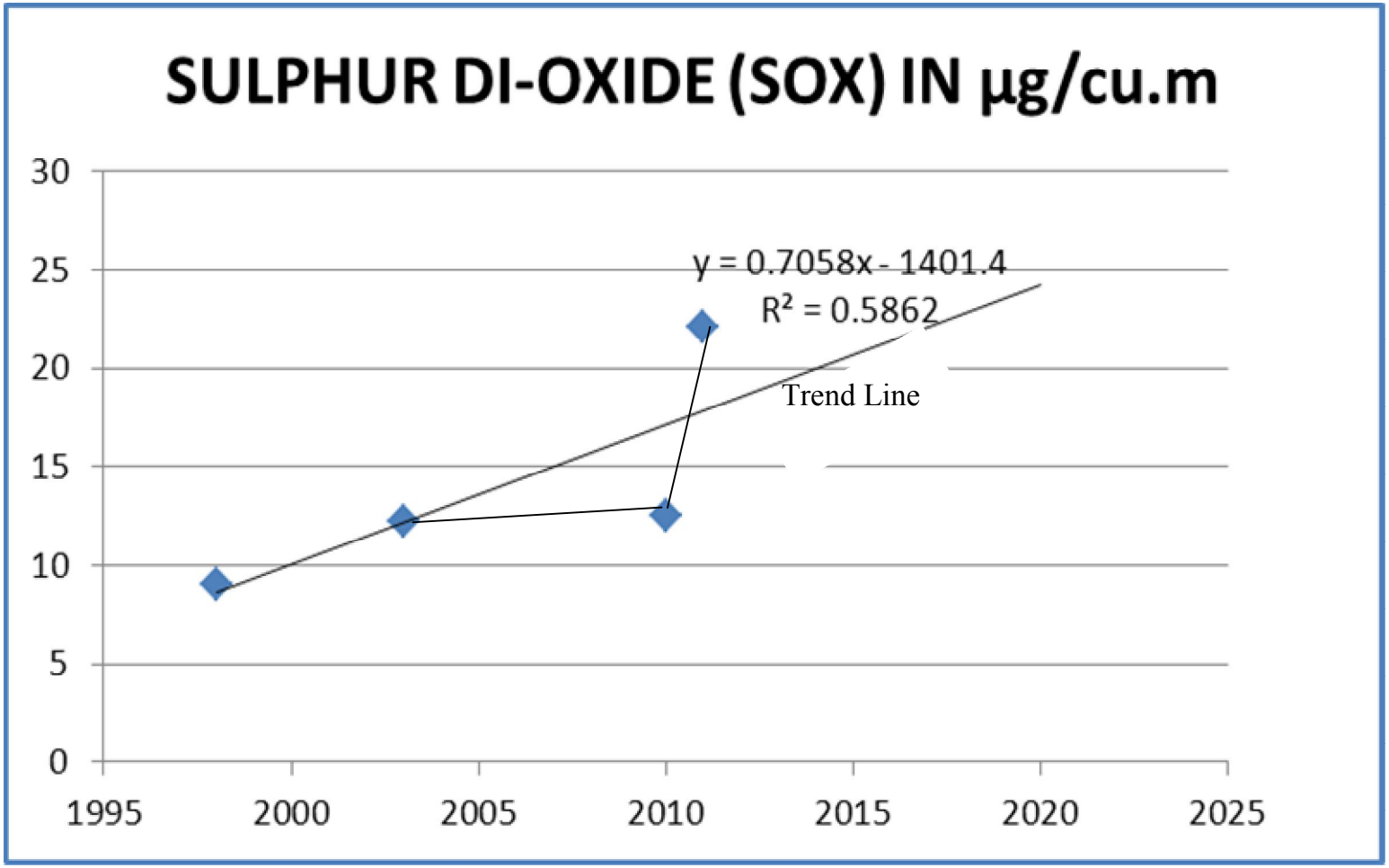

Average Value of NOx in (Summer 2011)

**FIGURE 6: TREND LINE OF $NO_X$ IN AMBIENT AIR OF KASHIPUR CITY FROM 1998 TILL 2012**



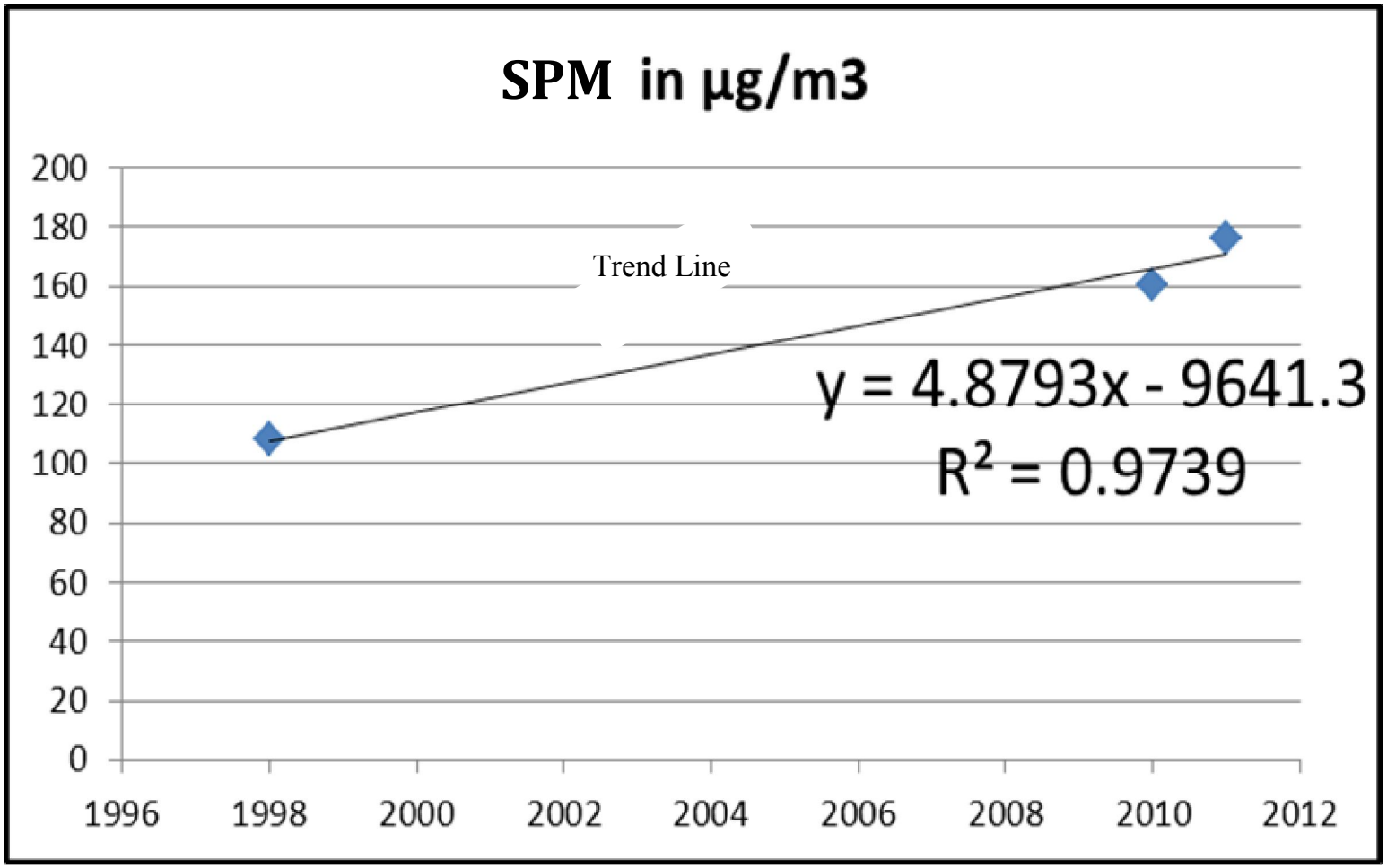

Trend line of NOx in ambient air of Kashipur City from 1998 till 2012

**FIGURE 7: TREND LINE OF $SO_2$ IN AMBIENT AIR OF KASHIPUR CITY FROM 1998 TILL 2012**




Trend line of $SO_2$ in ambient air of Kashipur City from 1998 till 2012

**FIGURE 8: TREND LINE OF SPM IN AMBIENT AIR OF KASHIPUR CITY FROM 1998 TILL 2012**




Trend line of SPM in ambient air of Kashipur City from 1998 till 2012

**FIGURE 9: NOISE LEVEL OF STUDY AREA IN dBA (DAY ) 2012**

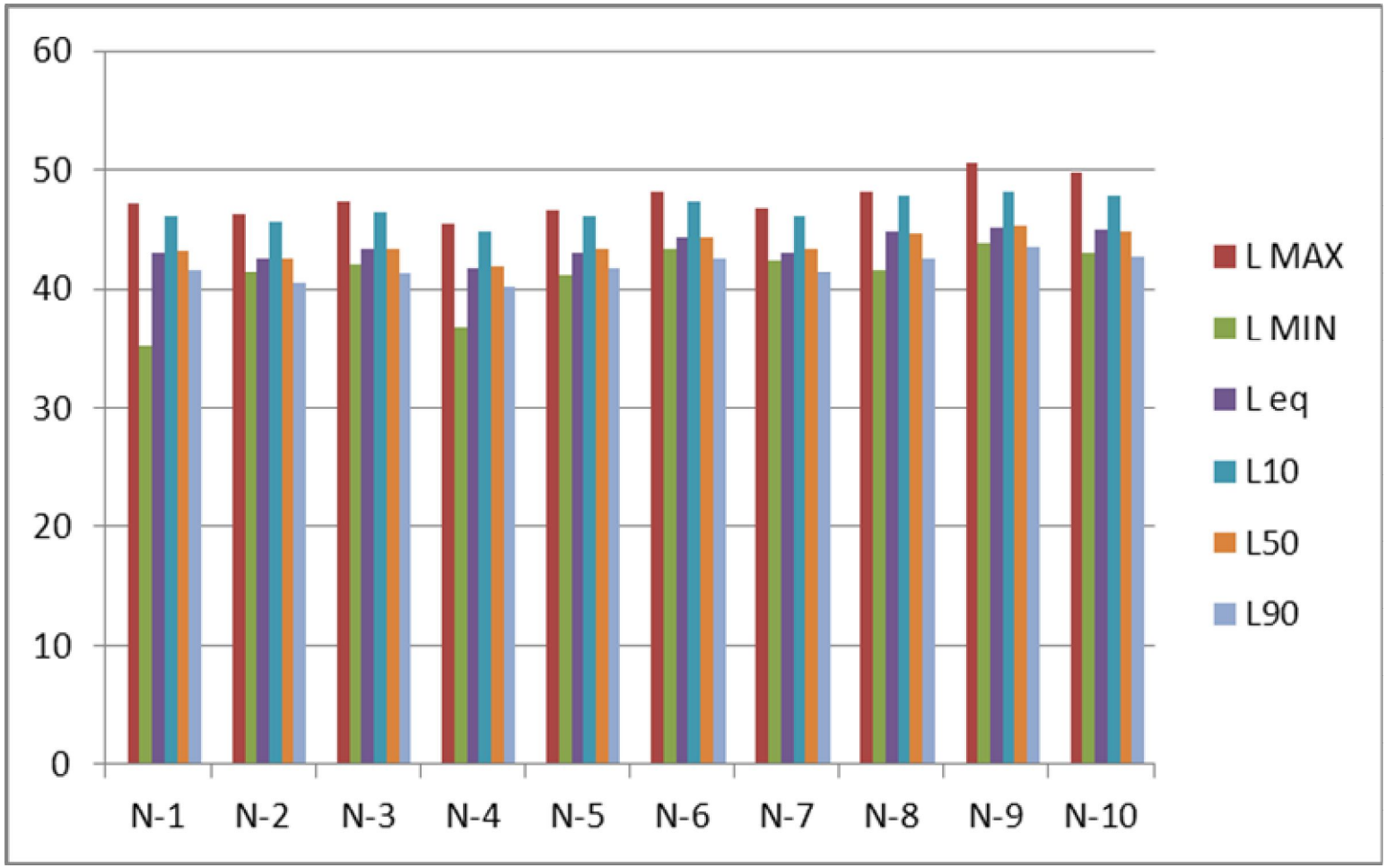
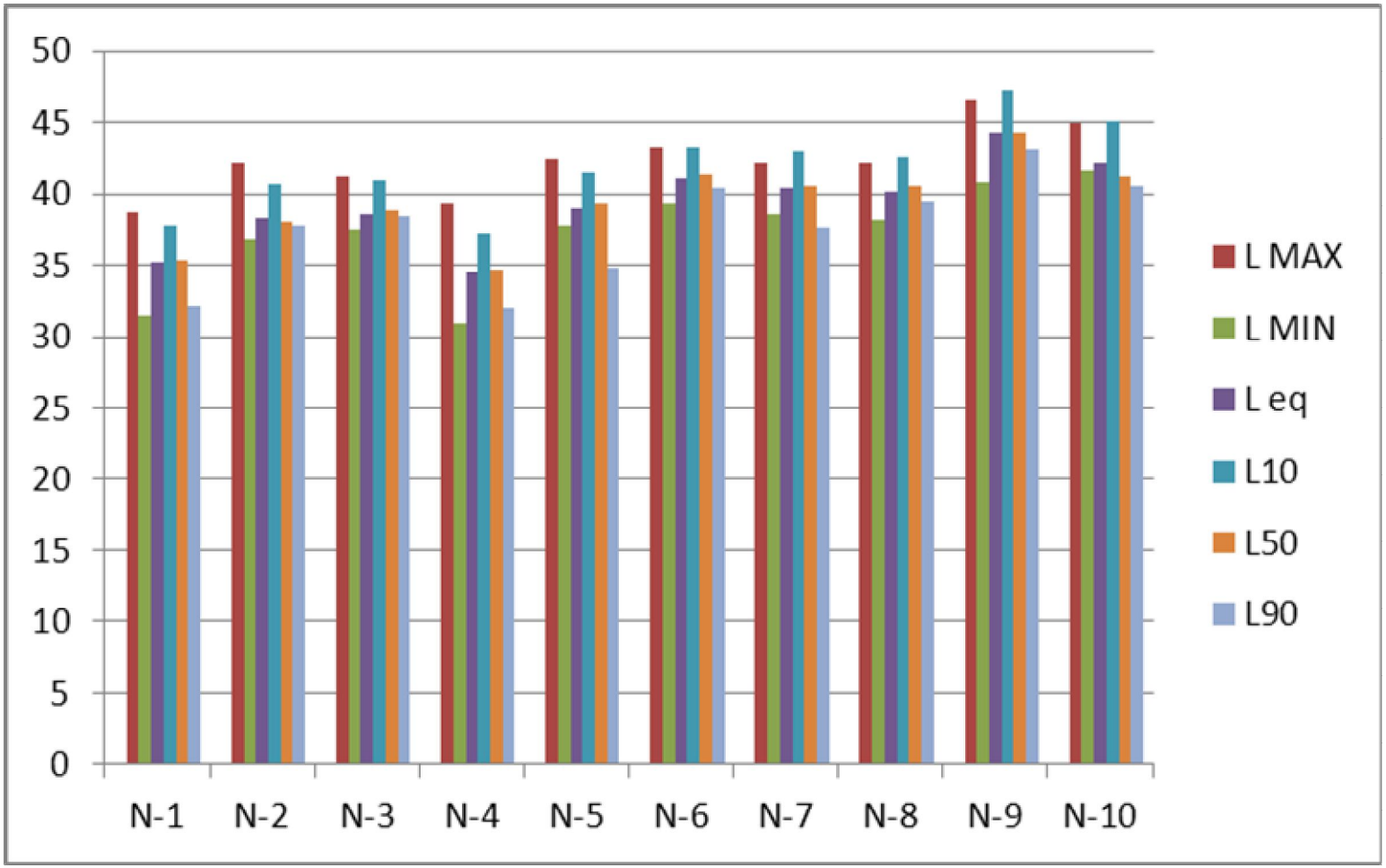


**FIGURE 10: NOISE LEVEL OF STUDY AREA IN dBA (NIGHT ) 2012**



**STATISTICAL ANALYSIS OF ENVIRONMENTAL PARAMETERS IN GROUND WATER OF GW-3 (DHAKIA KALAN) BETWEEN 1998 & 2011**

**FIGURE 11: TOTAL HARDNESS AS CACO3 AT SAMPLING POINT GW3-DAKIA KALAN**

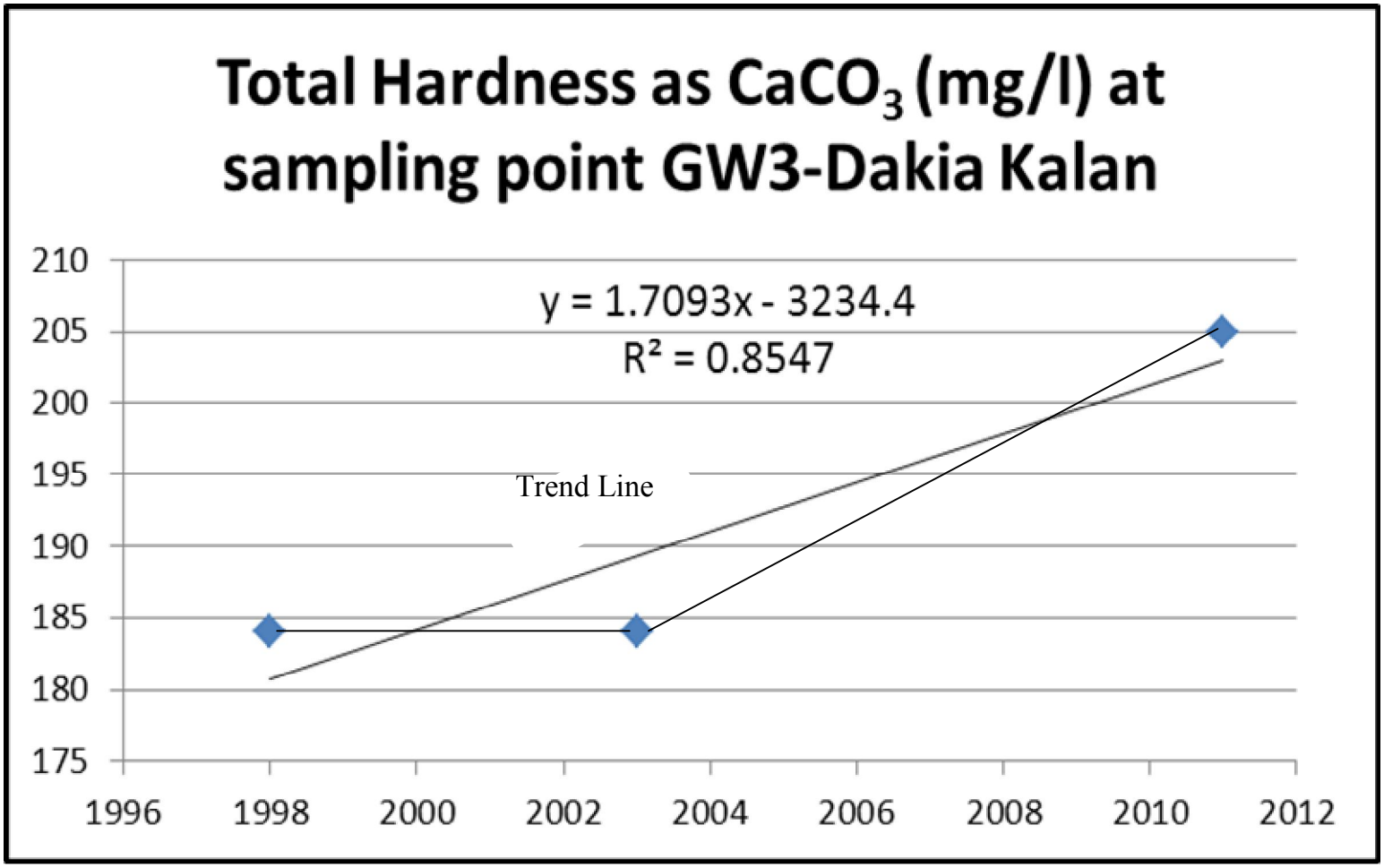


**FIGURE 12: CALCIUM HARDNESS AS CACO3 AT SAMPLING POINT GW3-DAKIA KALAN**

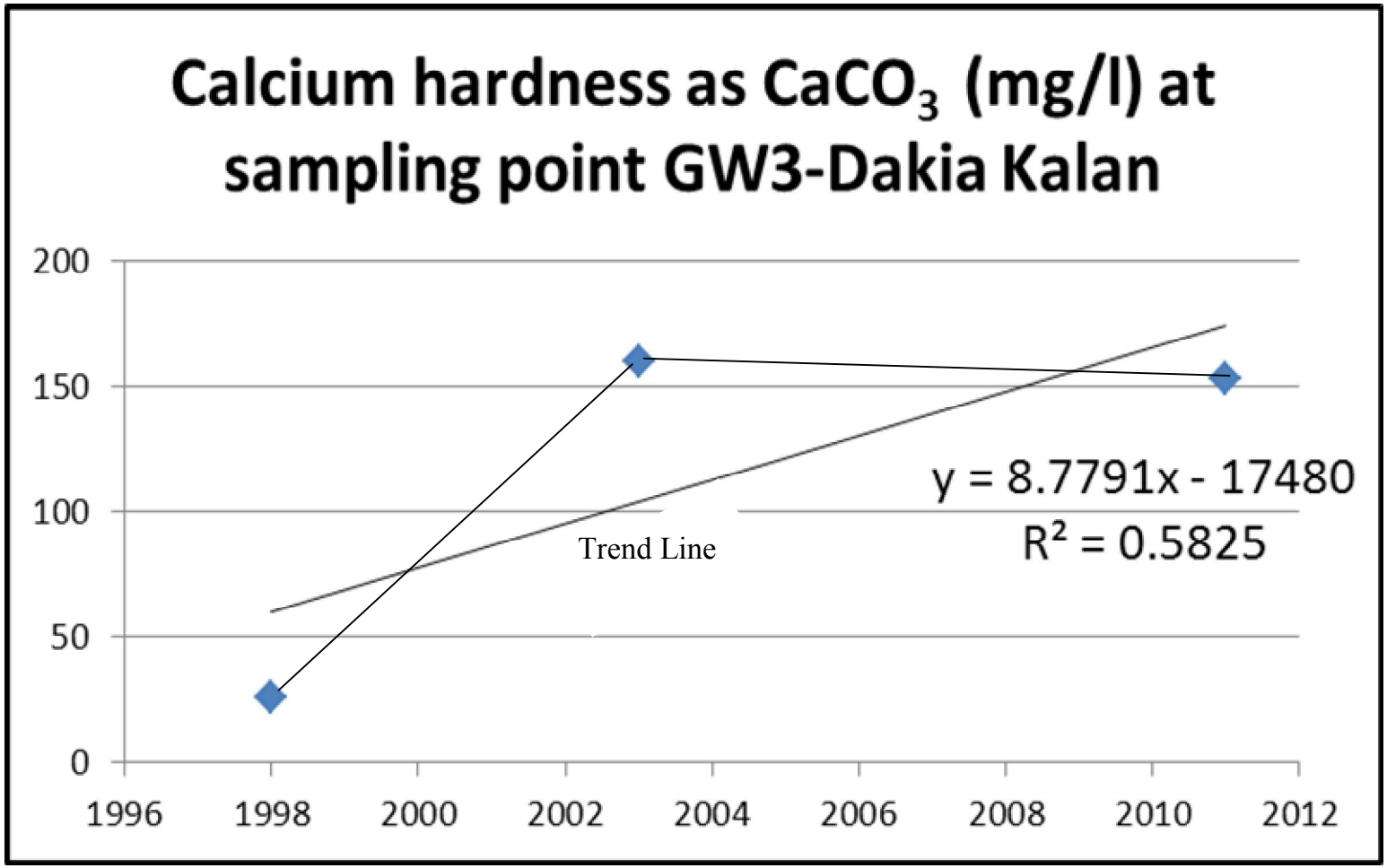


**FIGURE 13: SULFATE AS SO4 AT SAMPLING POINT GW3-DAKIA KALAN**

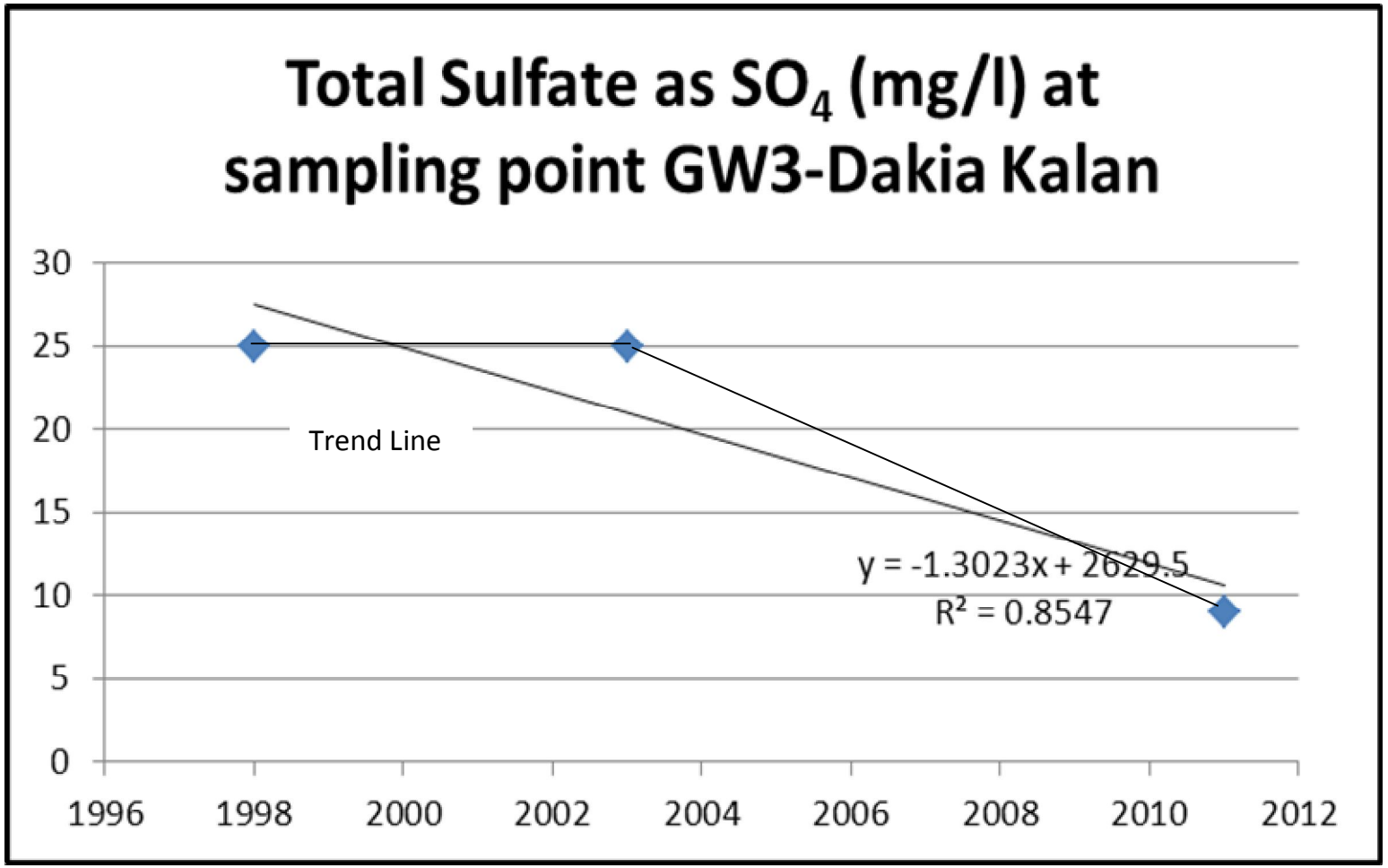


**FIGURE 14: TOTAL HARDNESS AS CACO3 AT SAMPLING POINT GW4- DHABORA MUSTAKHAM**

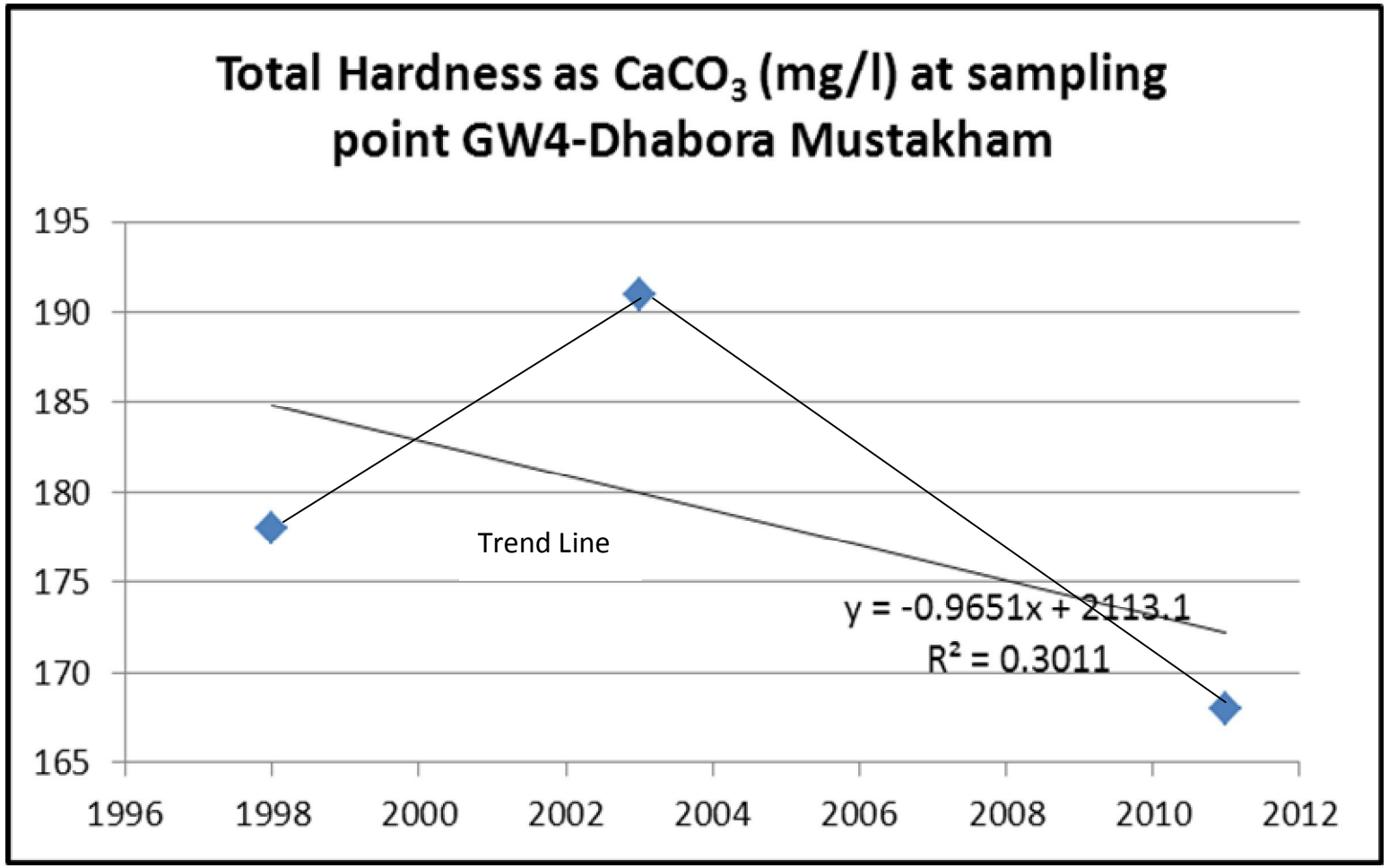


**FIGURE 15: TOTAL CALCIUM HARDNESS AS CACO3 AT SAMPLING POINT GW4- DHABORA MUSTAKHAM**

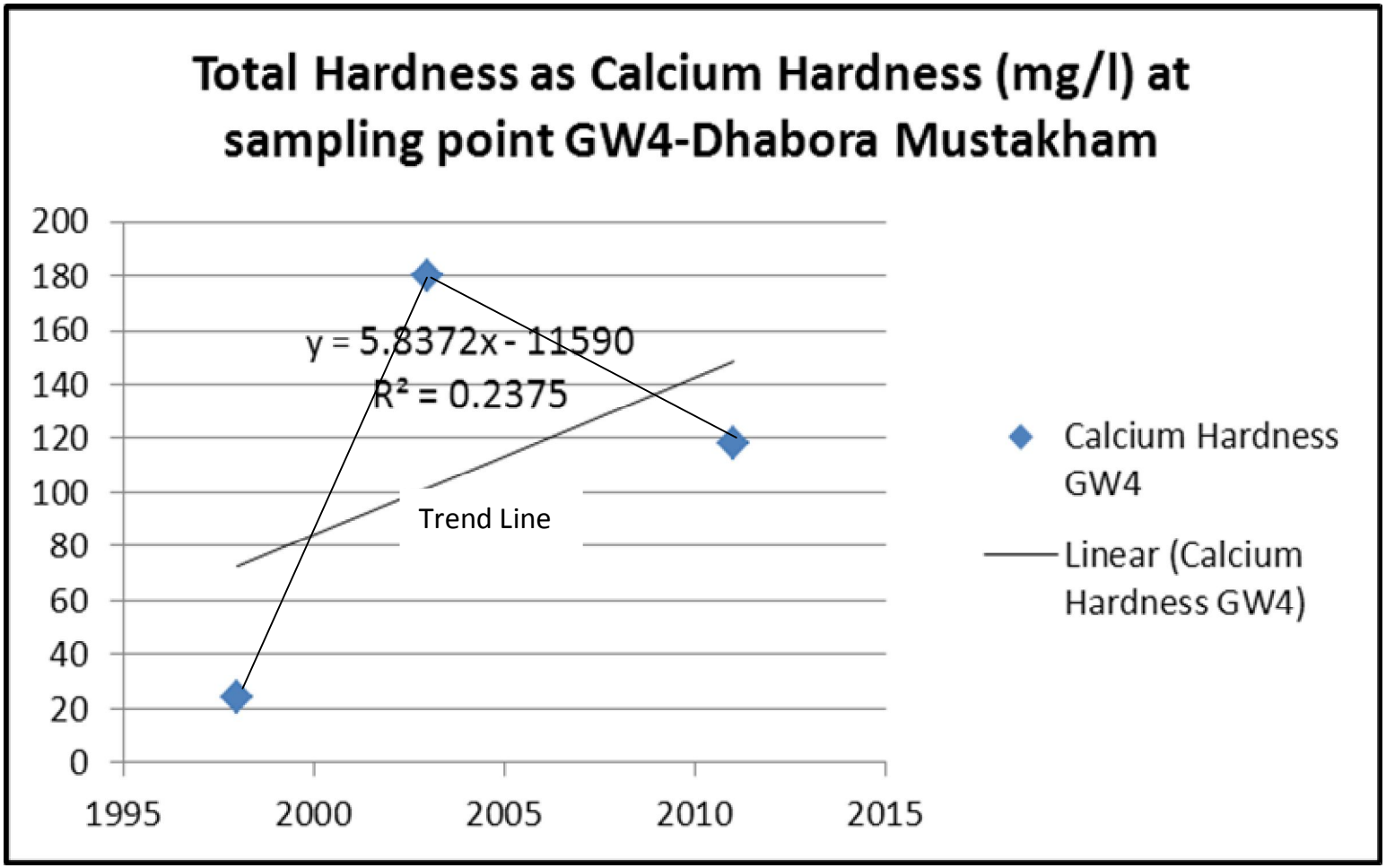


**FIGURE 16: SODIUM AS NA AT SAMPLING POINT GW4- DHABORA MUSTAKHAM**

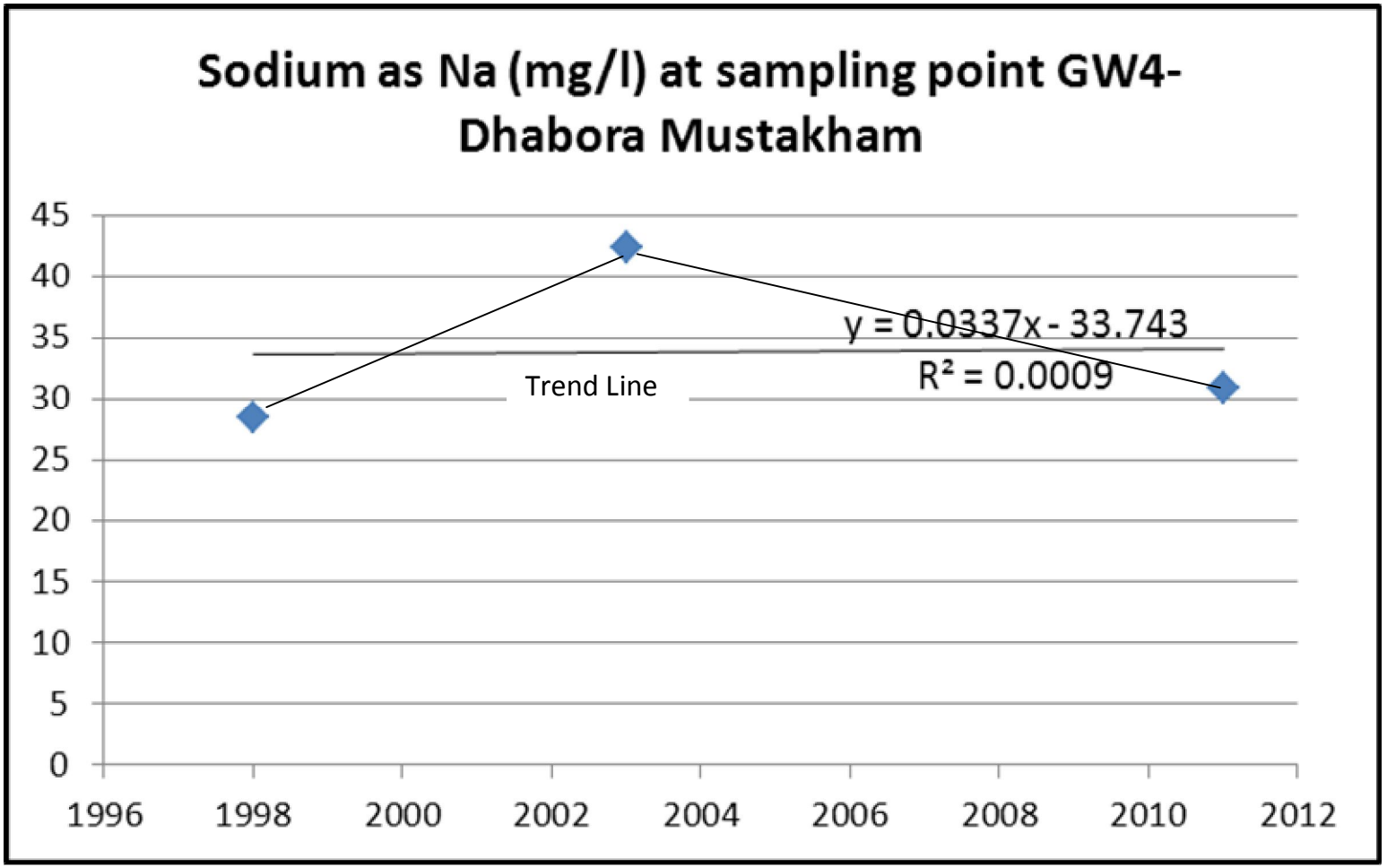
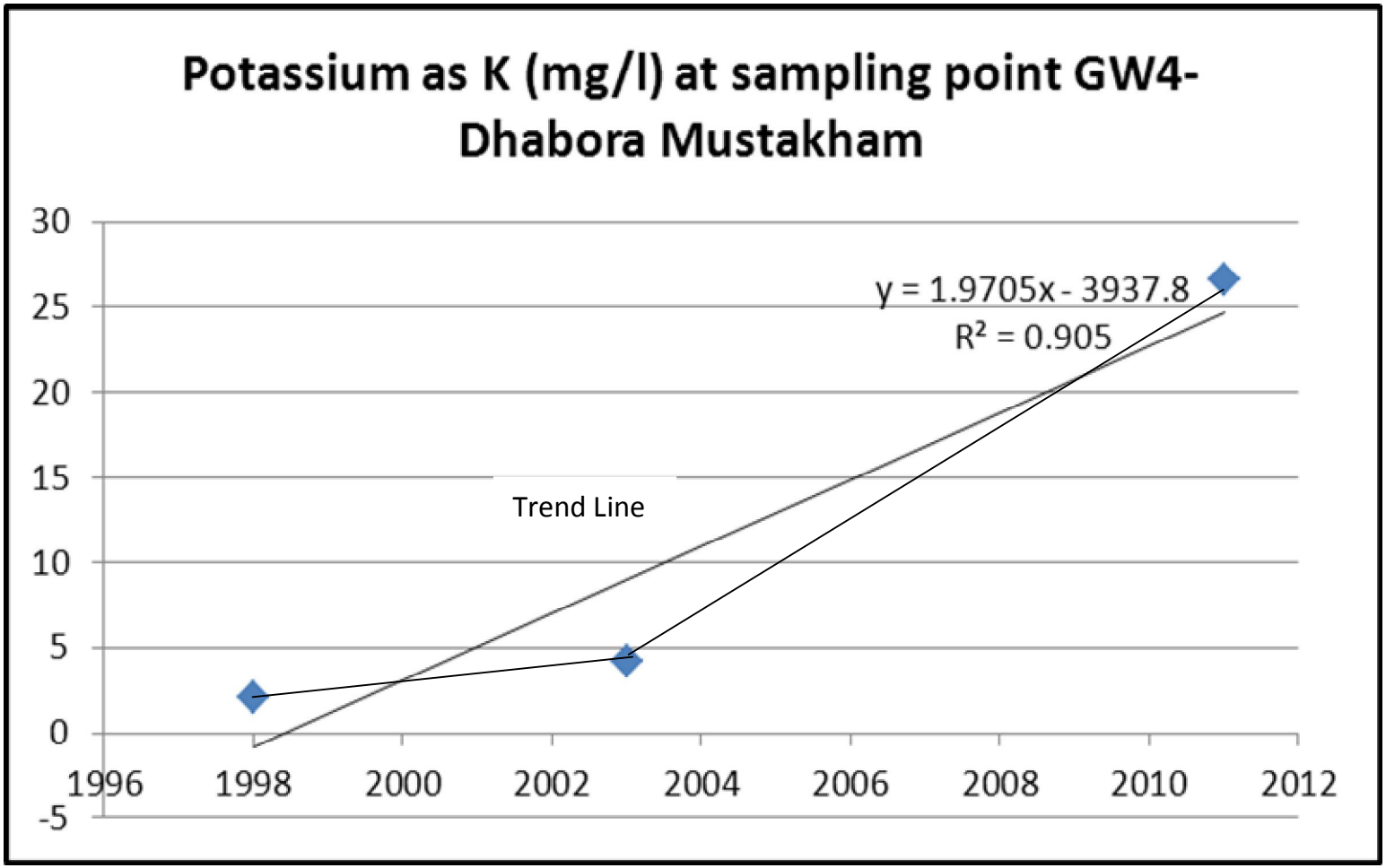


**FIGURE 17: POTASSIUM AS K AT SAMPLING POINT GW4- DHABORA MUSTAKHAM**



**Statistical analysis of Environmental Parameters in Surface water of SW-4 KOSI RIVER-U/S between 1998 & 2011**

**FIGURE 18: TDS AT SAMPLING POINT SW-4 KOSI RIVER-U/S**

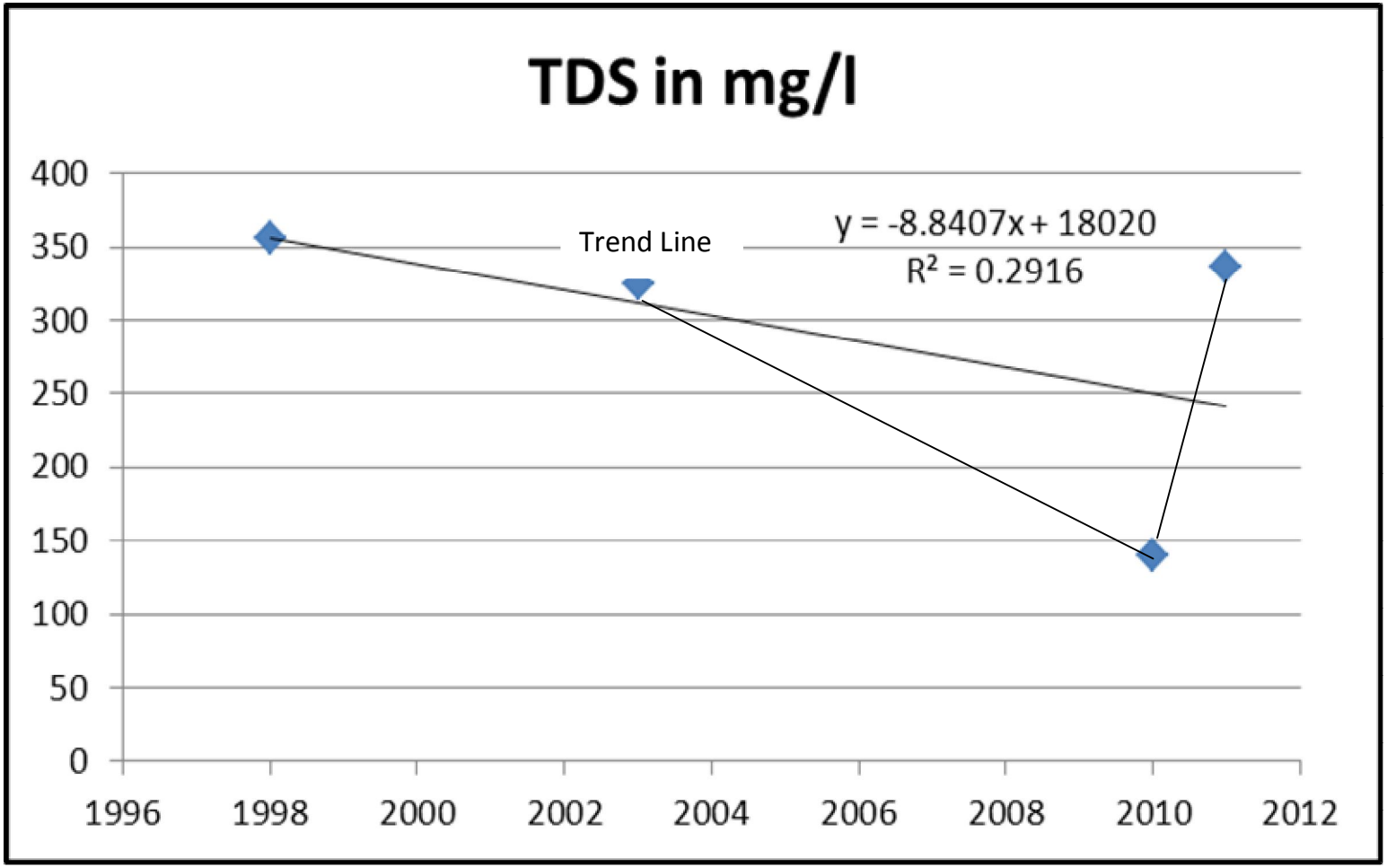


**FIGURE 19: TSS AT SAMPLING POINT SW-4 KOSI RIVER-U/S**

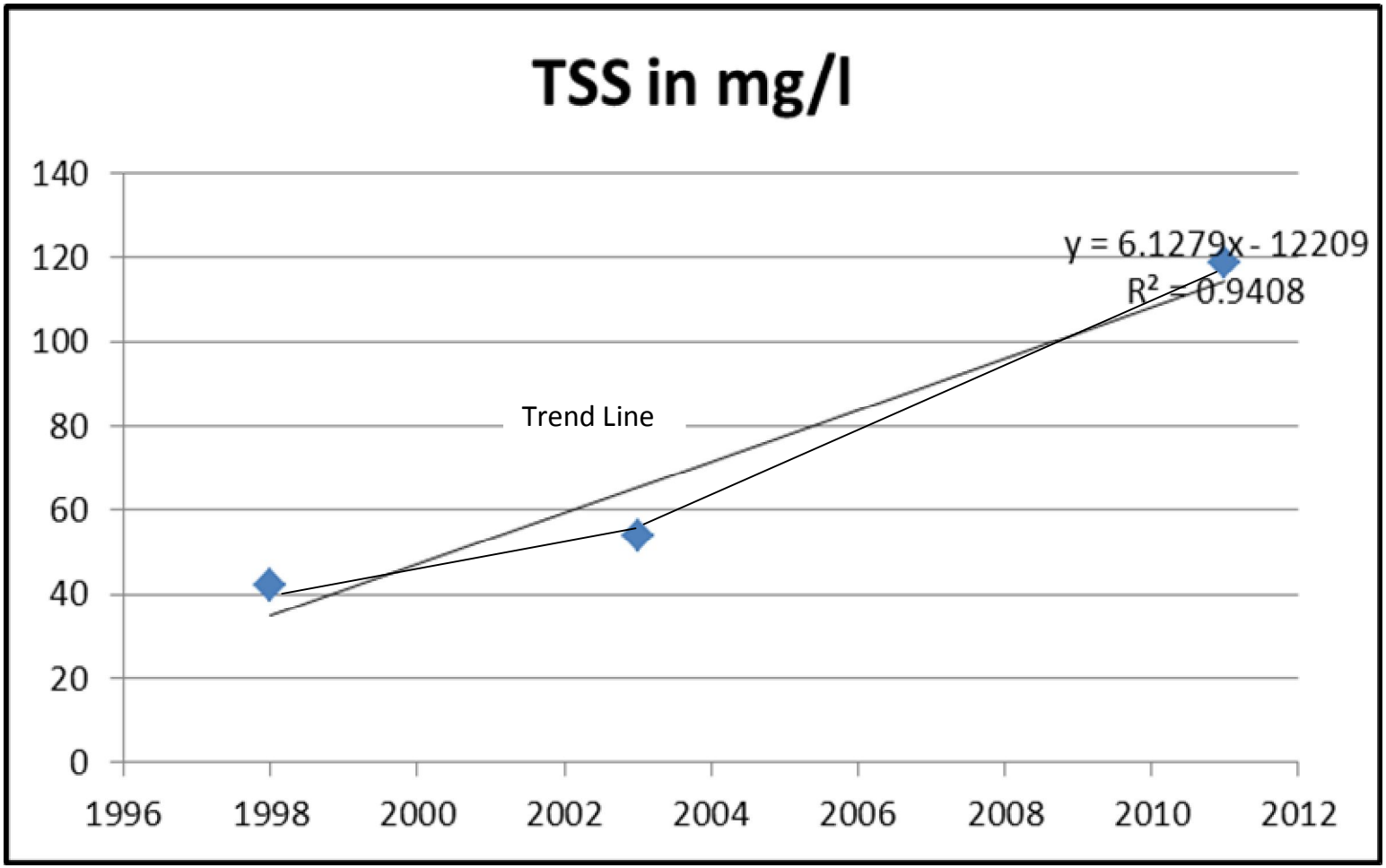


**FIGURE 20: BOD (3 DAYS AT 27 DEG C) AT SAMPLING POINT SW-4 KOSI RIVER-U/S**

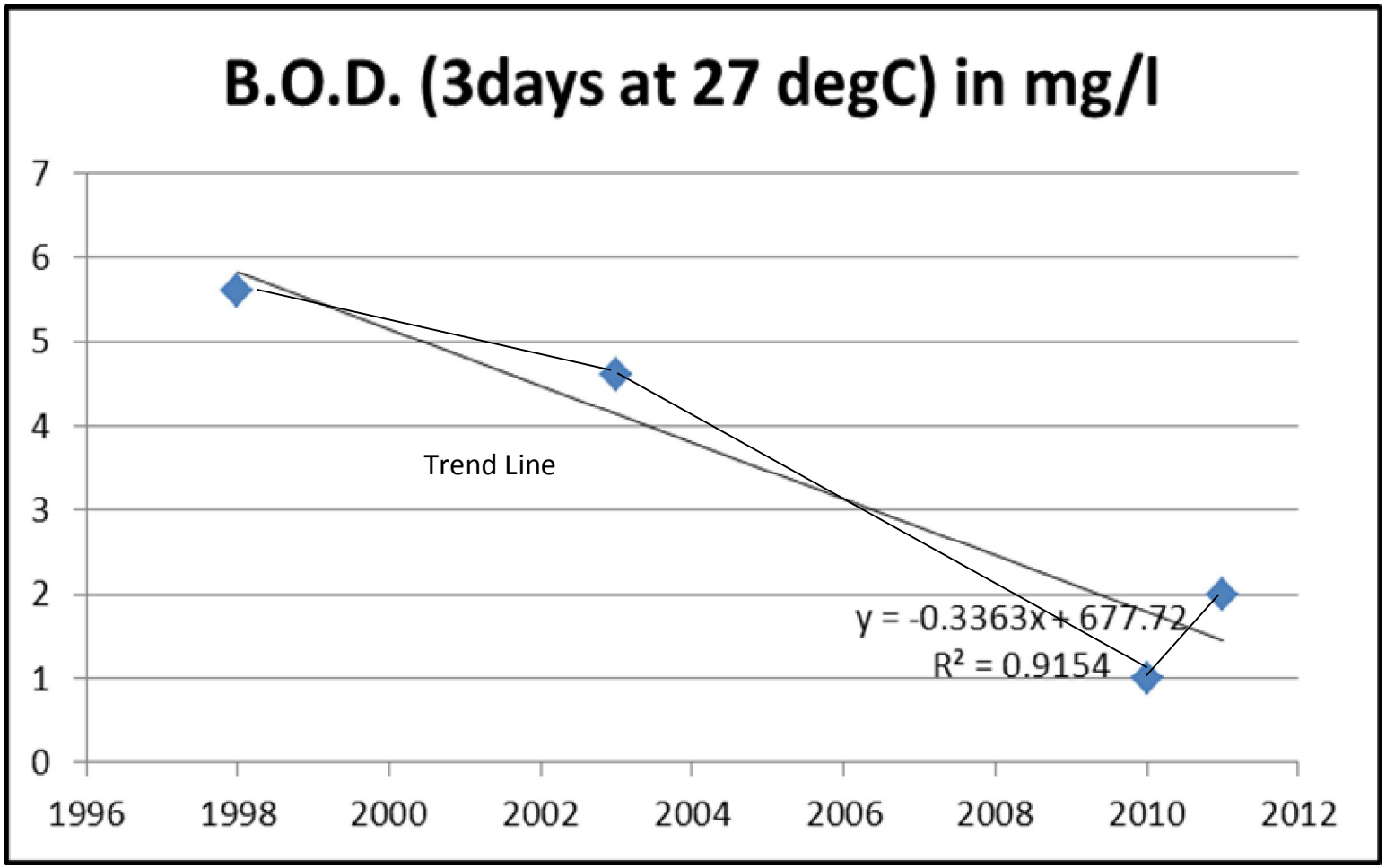


**FIGURE 21: COD AT SAMPLING POINT SW-4 KOSI RIVER-U/S**

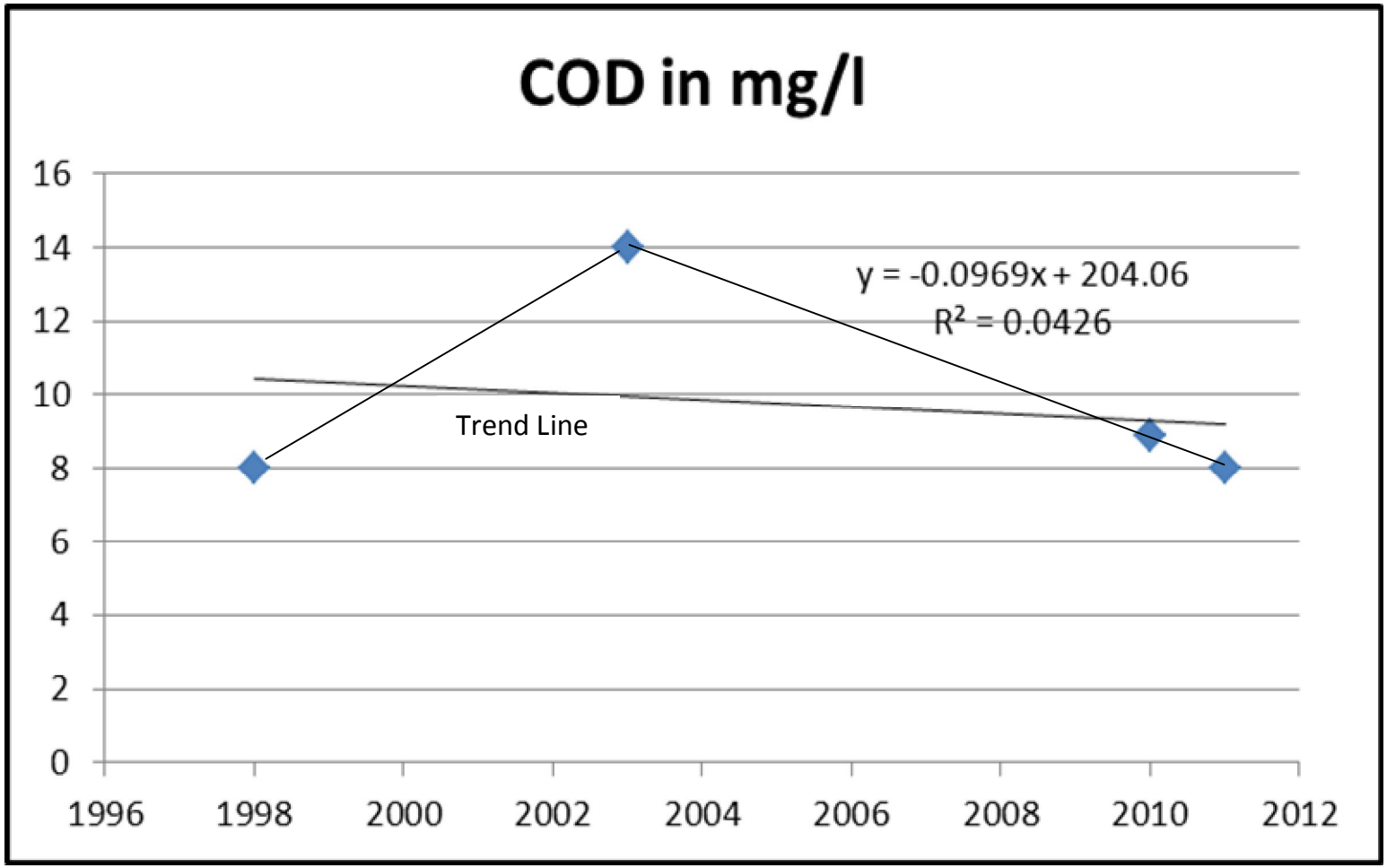


**FIGURE 22: TOTAL HARDNESS AS CACO3 AT SAMPLING POINT SW-4 KOSI RIVER-U/S**

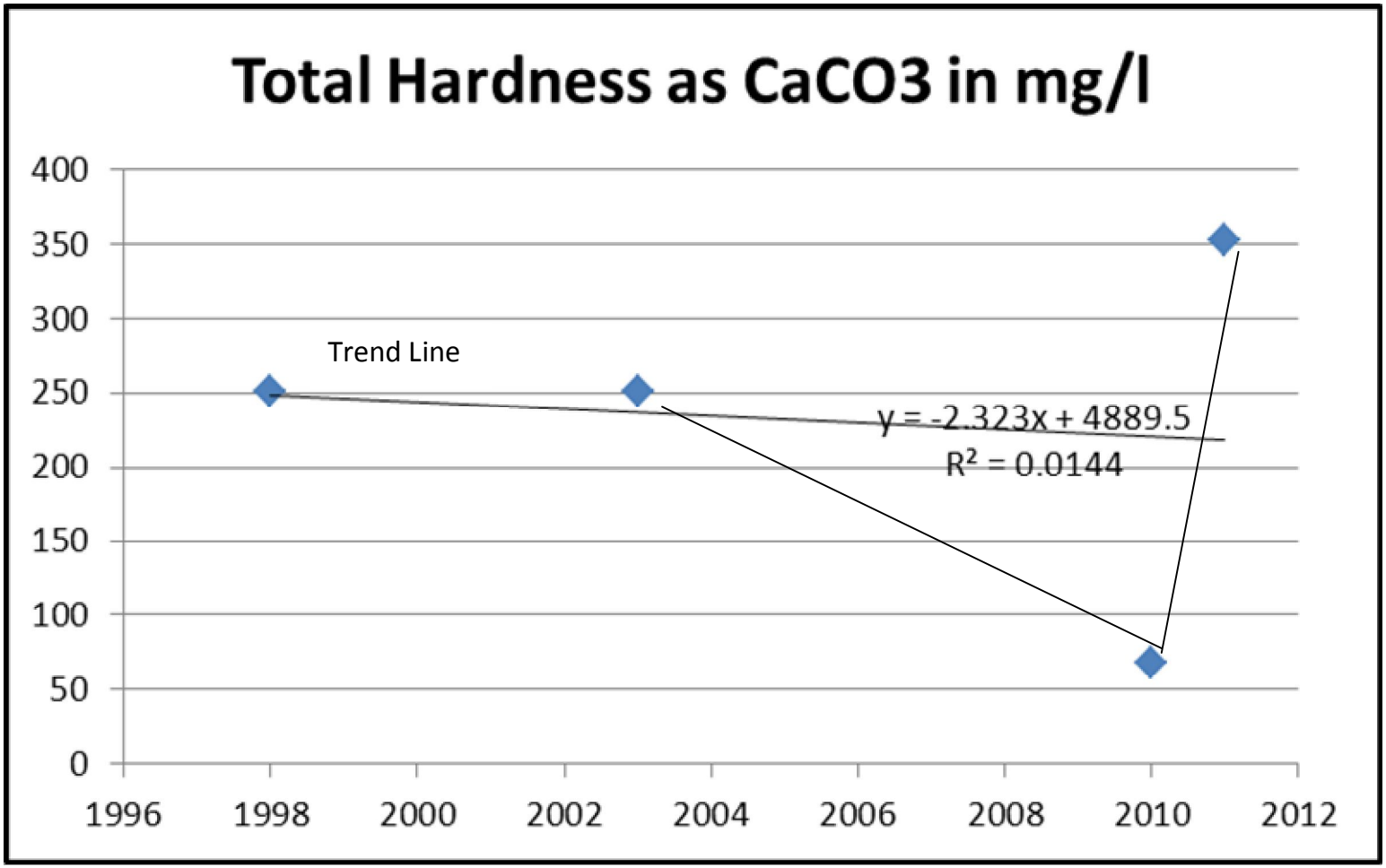


**FIGURE 23: TOTAL ALKALINITY AS CACO3 AT SAMPLING POINT SW-4 KOSI RIVER-U/S**

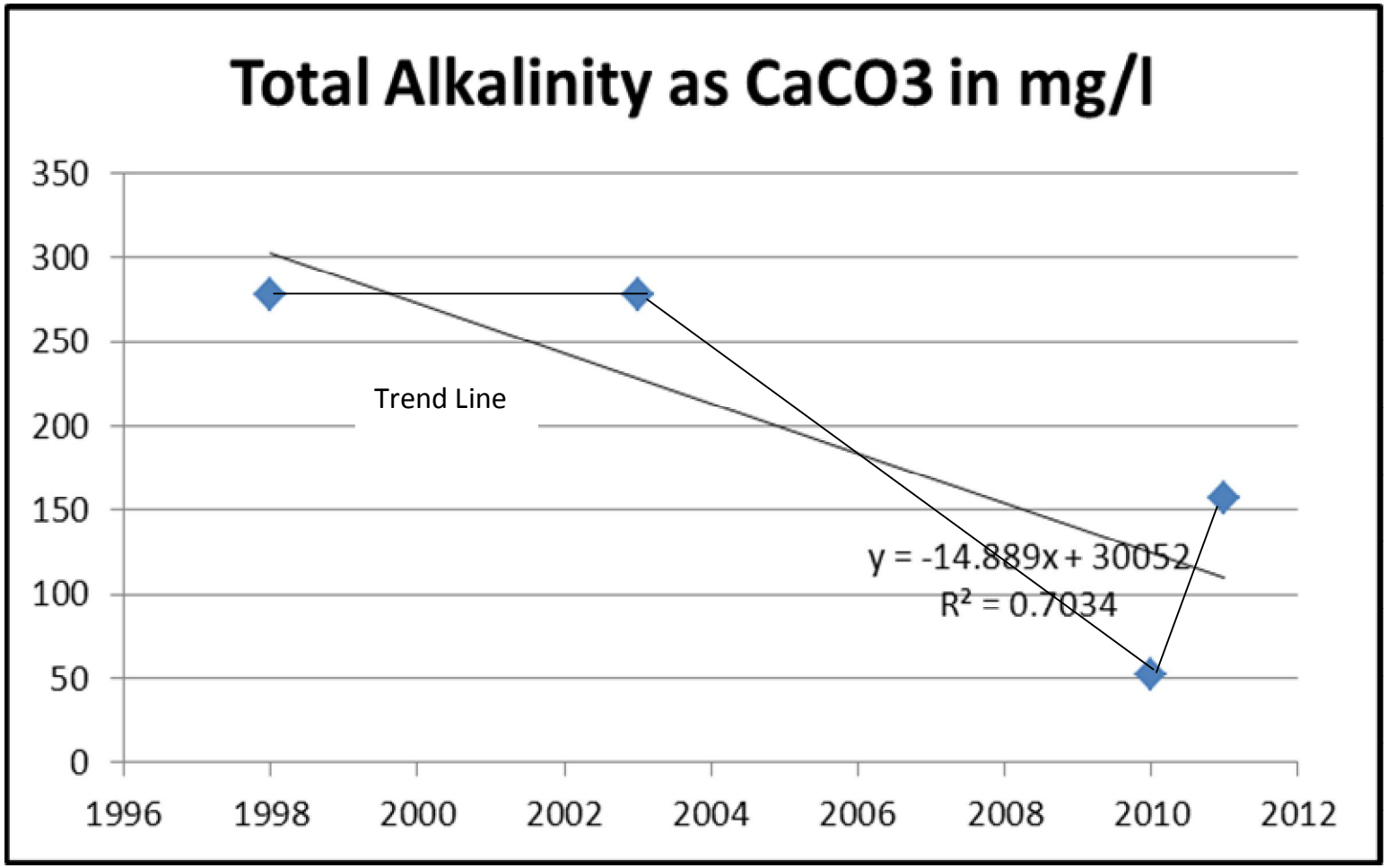
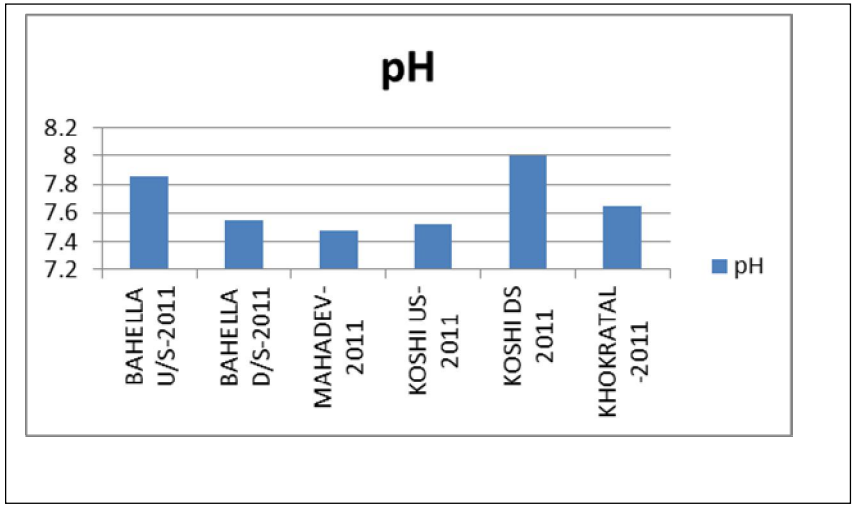
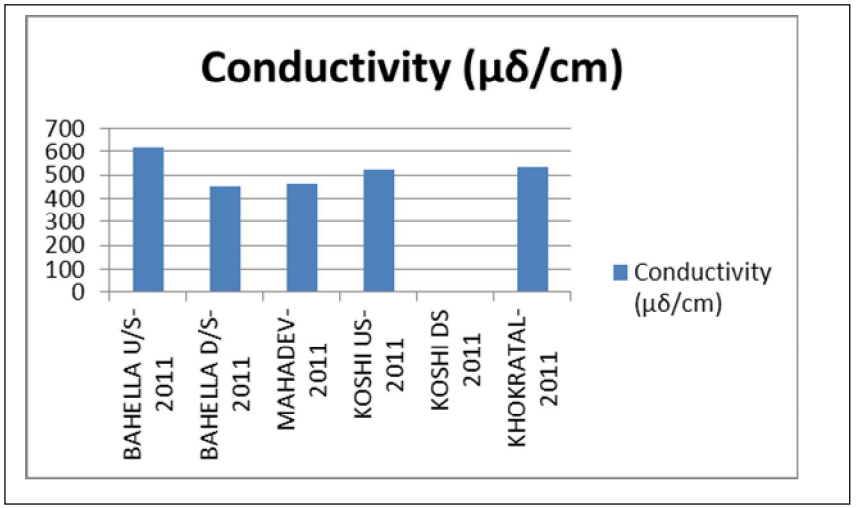
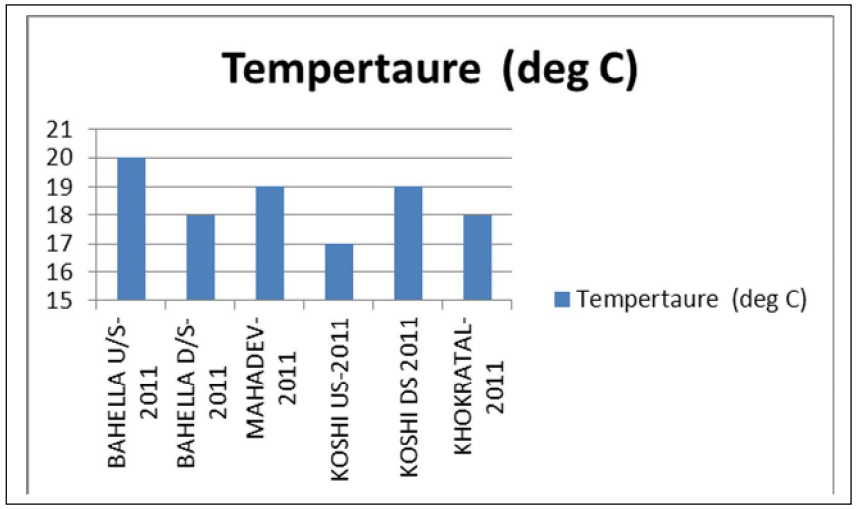


**FIGURE 24: ANALYSIS OF SURFACE WATER (pH, CONDUCTIVITY, TEMPERATURE & TURBIDITY)**



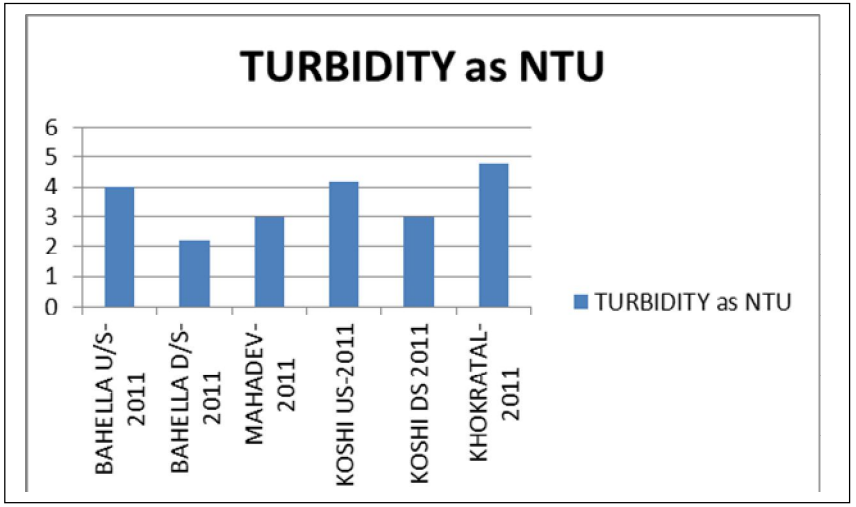
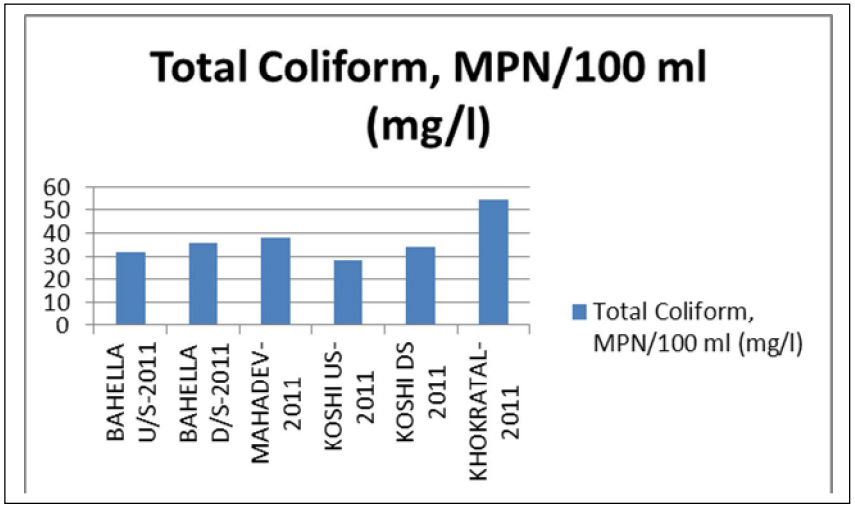
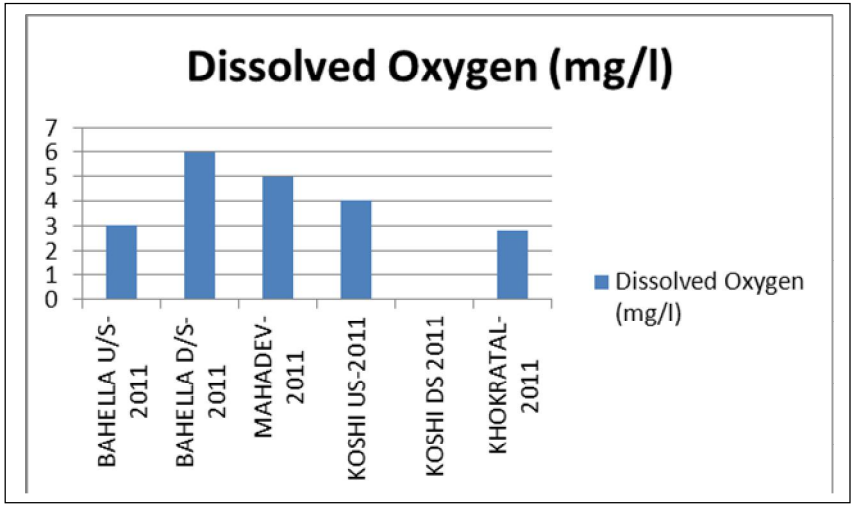
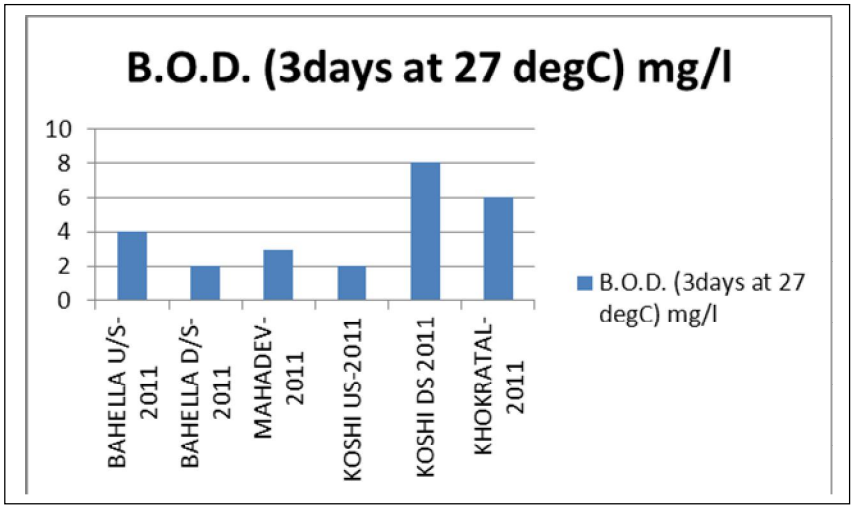



**FIGURE 25: ANALYSIS OF SURFACE WATER (TOTAL COLIFORM, DO, BOD & COD)**



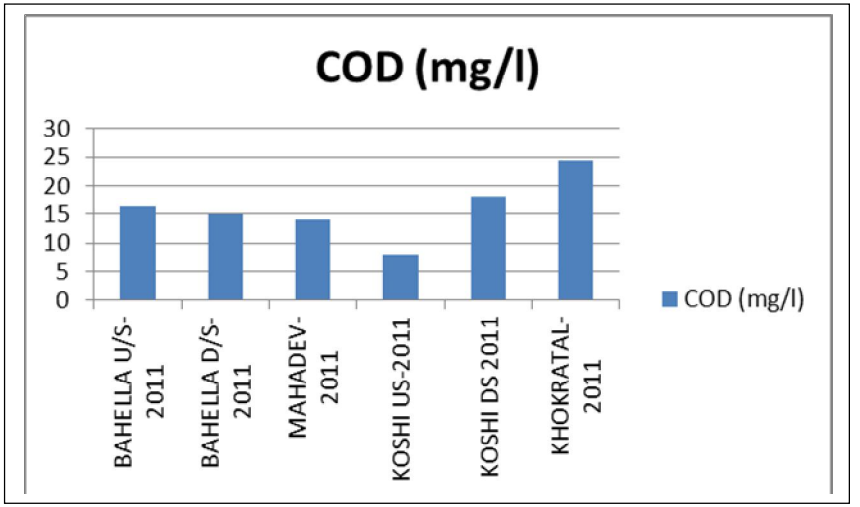



**FIGURE 26: ANALYSIS OF SURFACE WATER (TOTAL HARDNESS, ALKALINITY, CHLORIDES & NITRITES)**

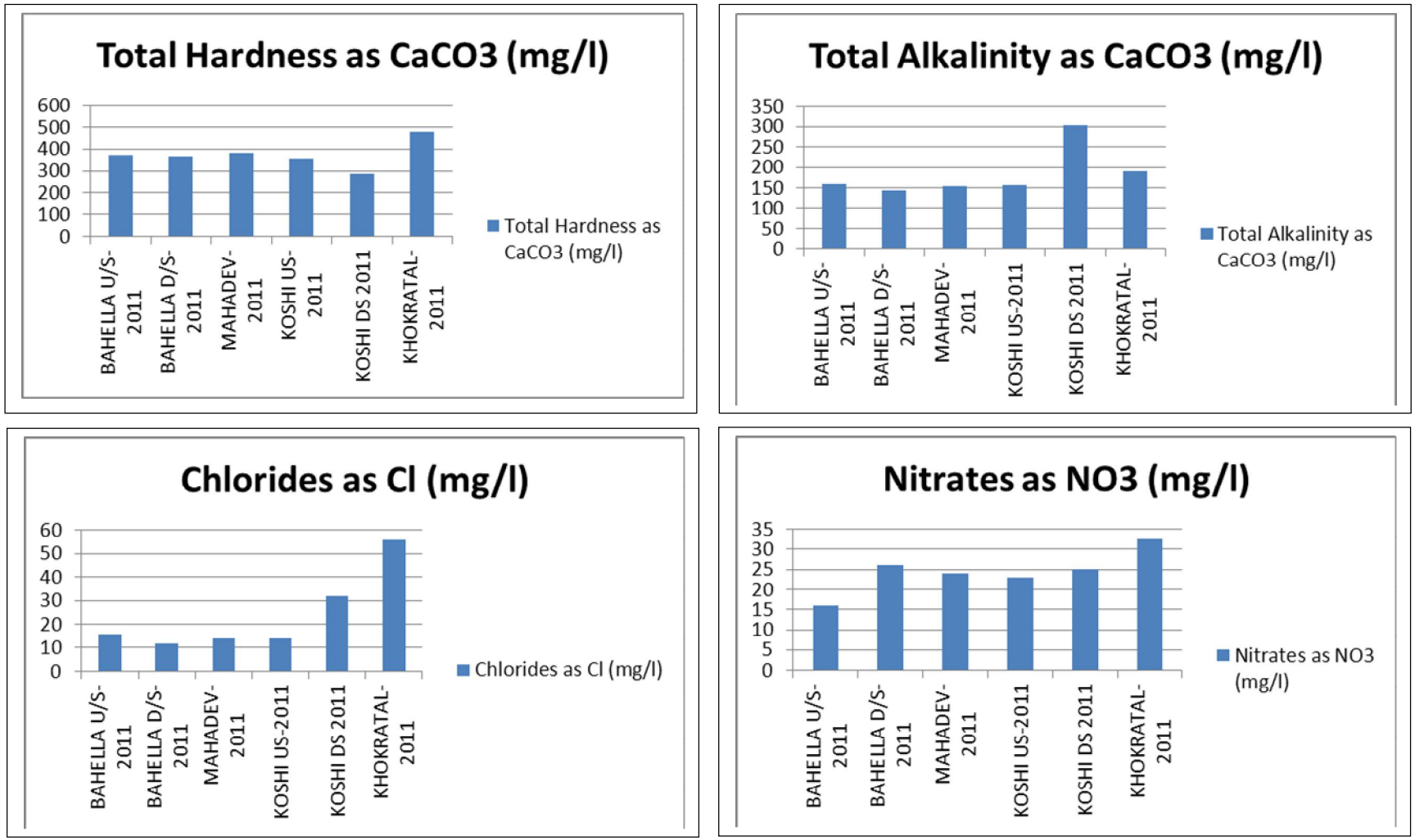
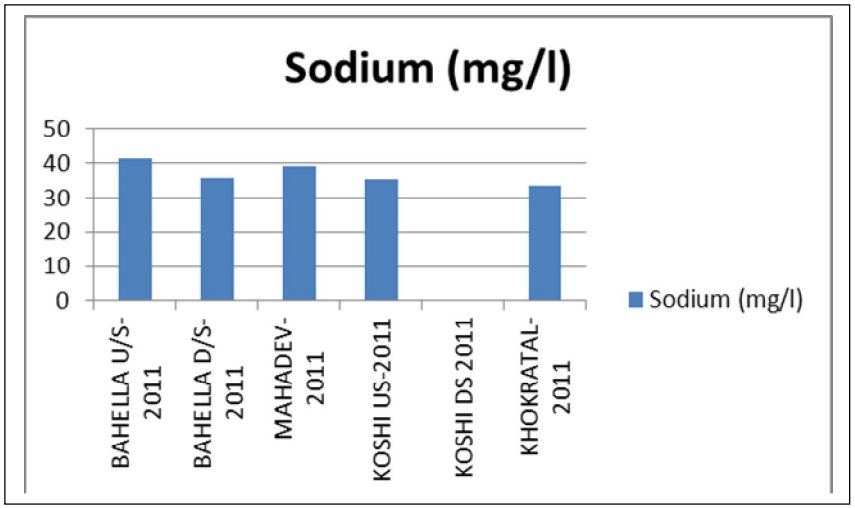
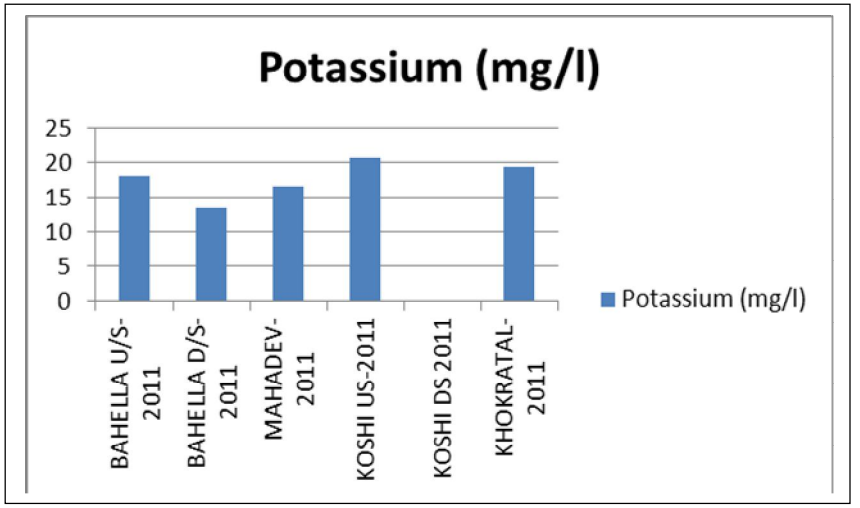
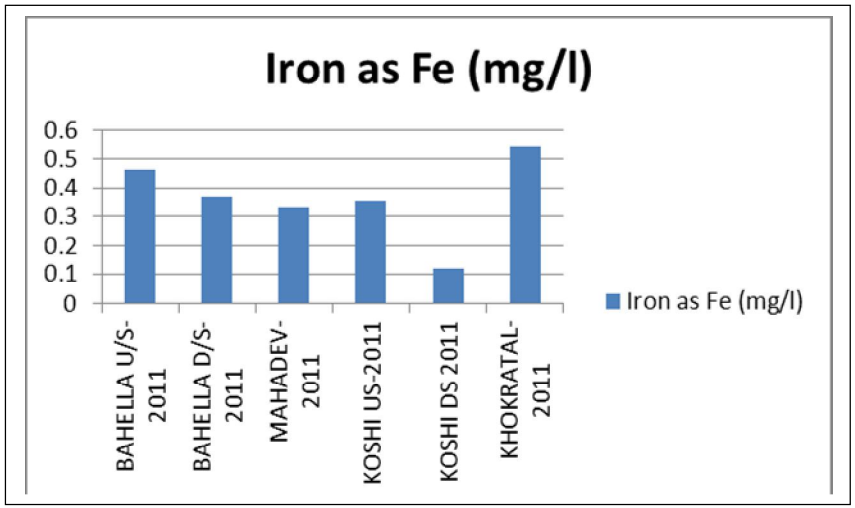
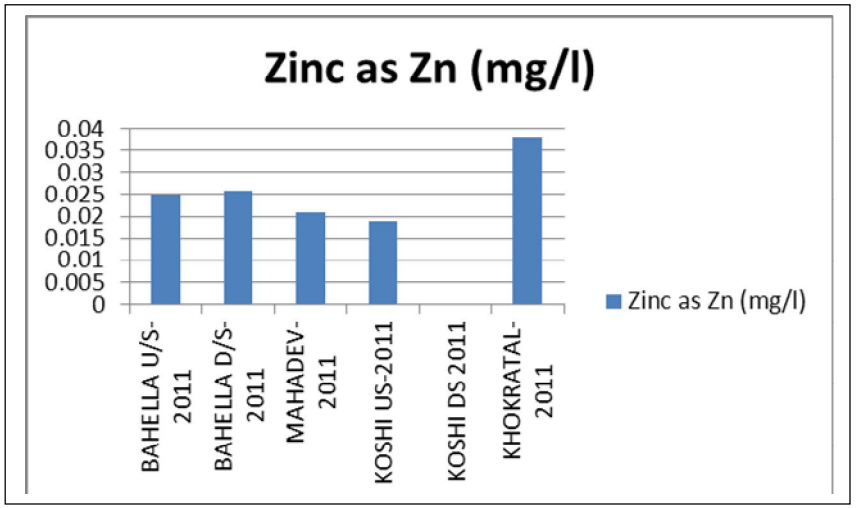


**FIGURE 27: ANALYSIS OF SURFACE WATER (SODIUM, POTASSIUM, IRON & ZINC)**



## ANALYSIS OF SOIL QUALITY

**FIGURE 28: COMPREHENSIVE VALUE OF pH SOIL SAMPLE OF 2011**

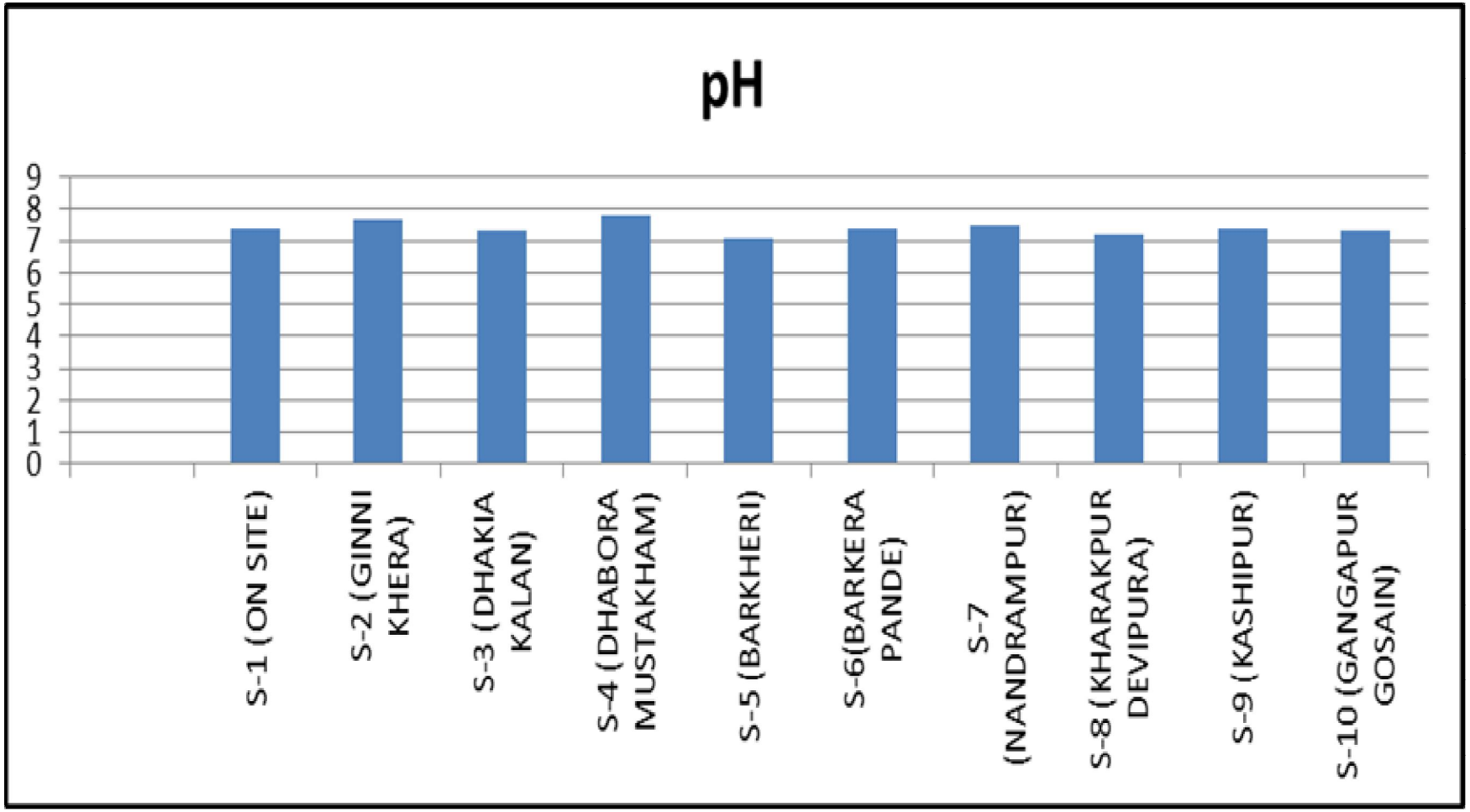


**FIGURE 29: COMPREHENSIVE VALUE OF CONDUCTIVITY SOIL SAMPLE OF 2011**

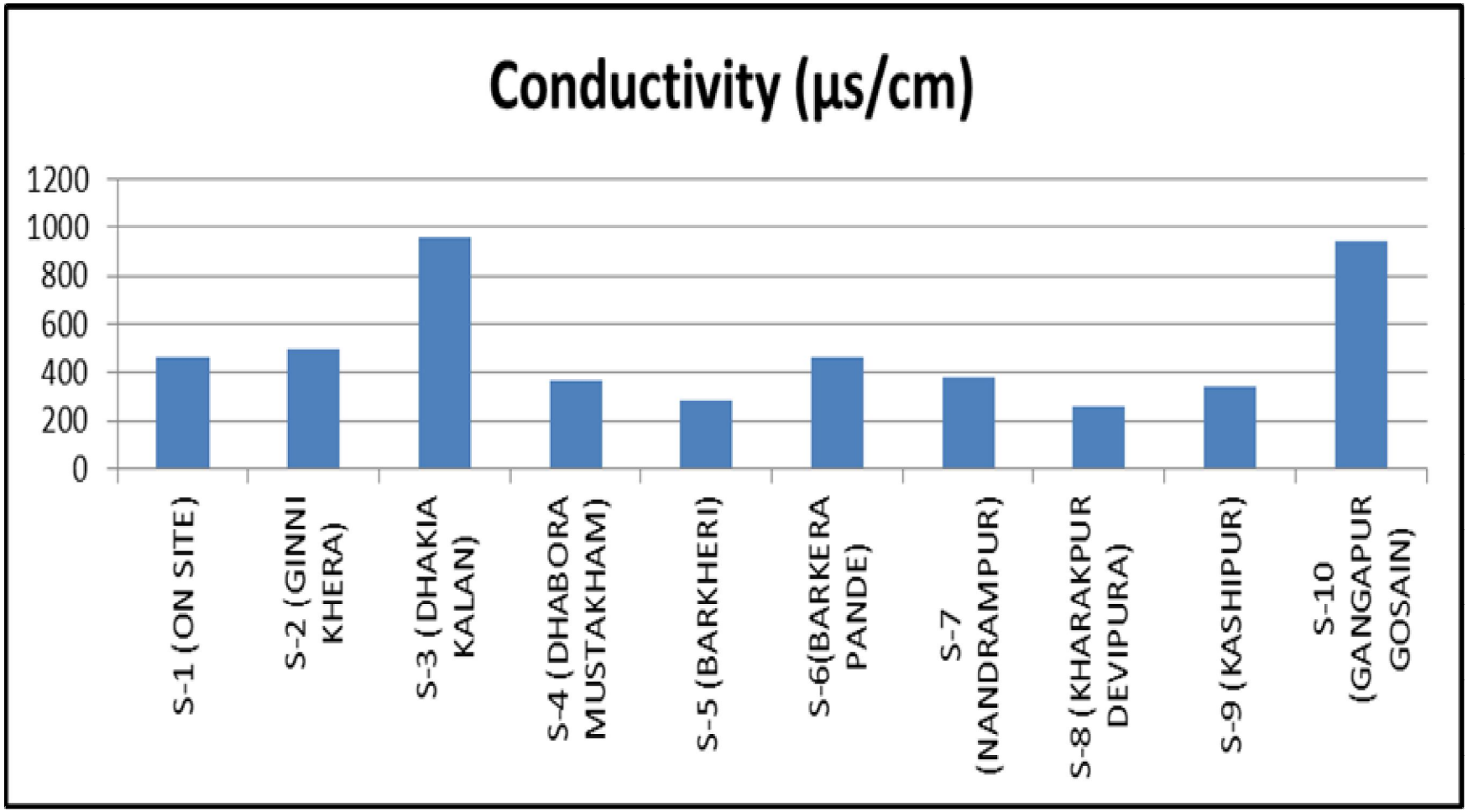


**FIGURE 30: COMPREHENSIVE VALUE OF SODIUM IN SOIL SAMPLE OF 2011**

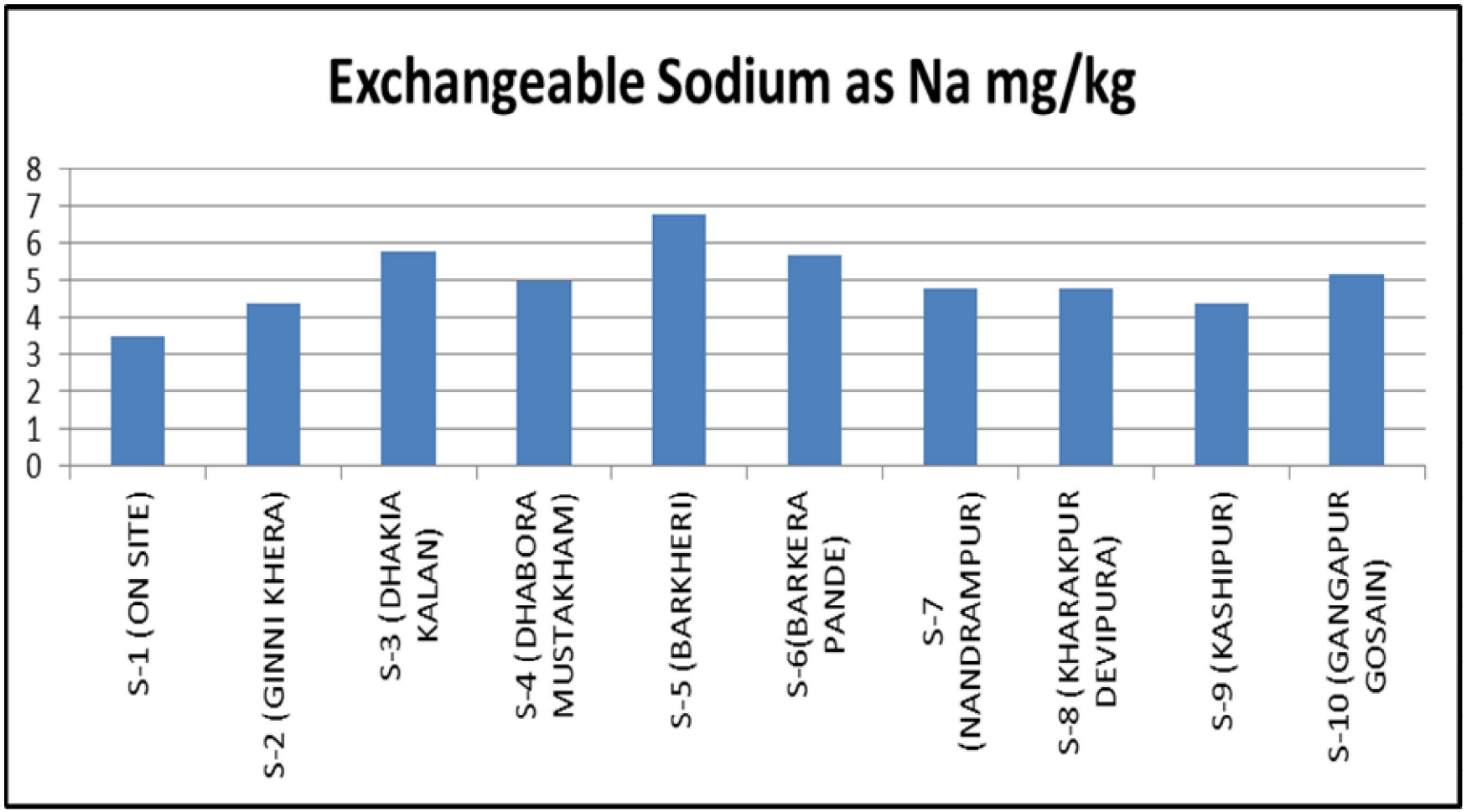


**FIGURE 31:: COMPREHENSIVE VALUE OF POTASSIUM IN SOIL SAMPLE OF 2011**

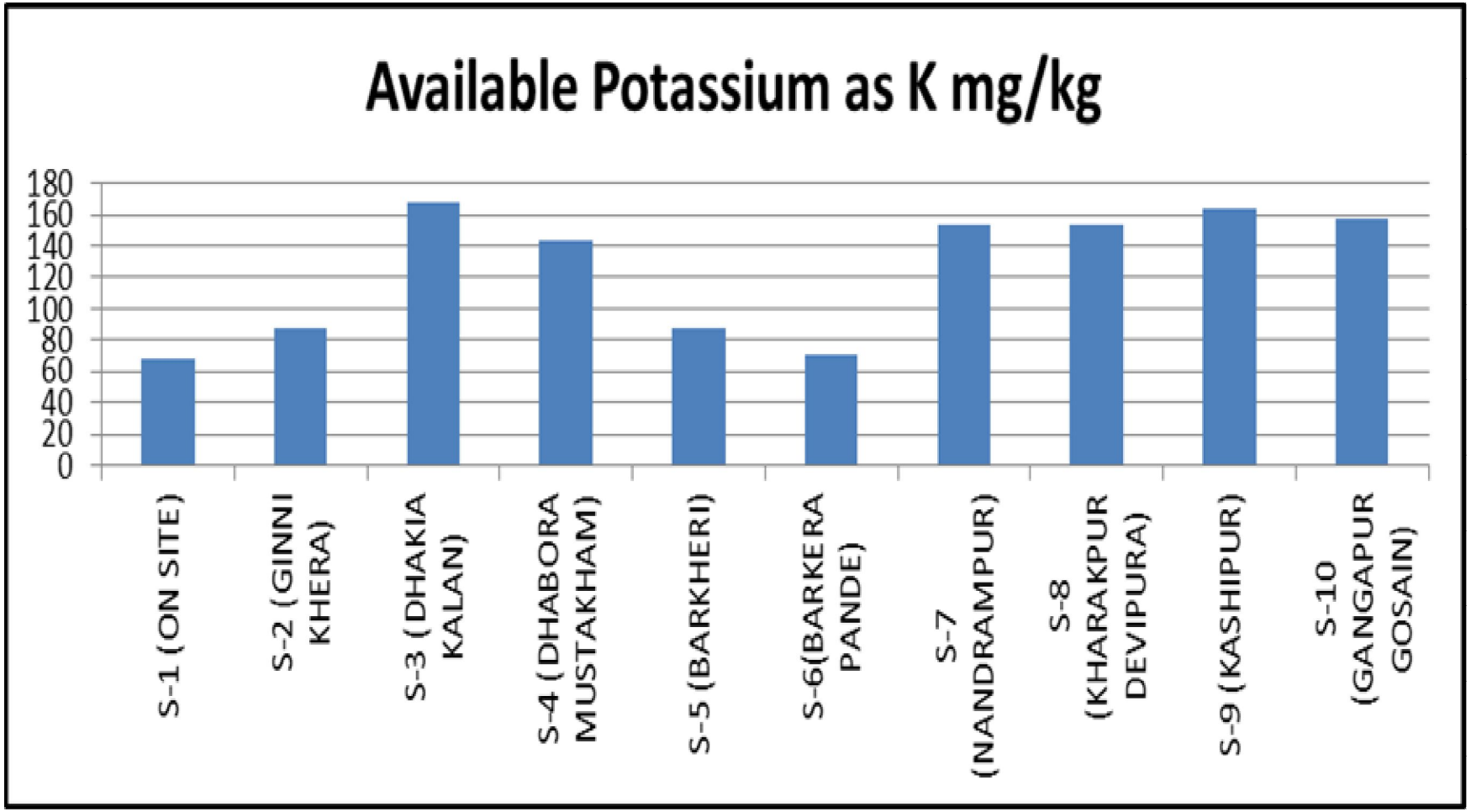


**FIGURE 32: COMPREHENSIVE VALUE OF CALCIUM IN SOIL SAMPLE OF 2011**

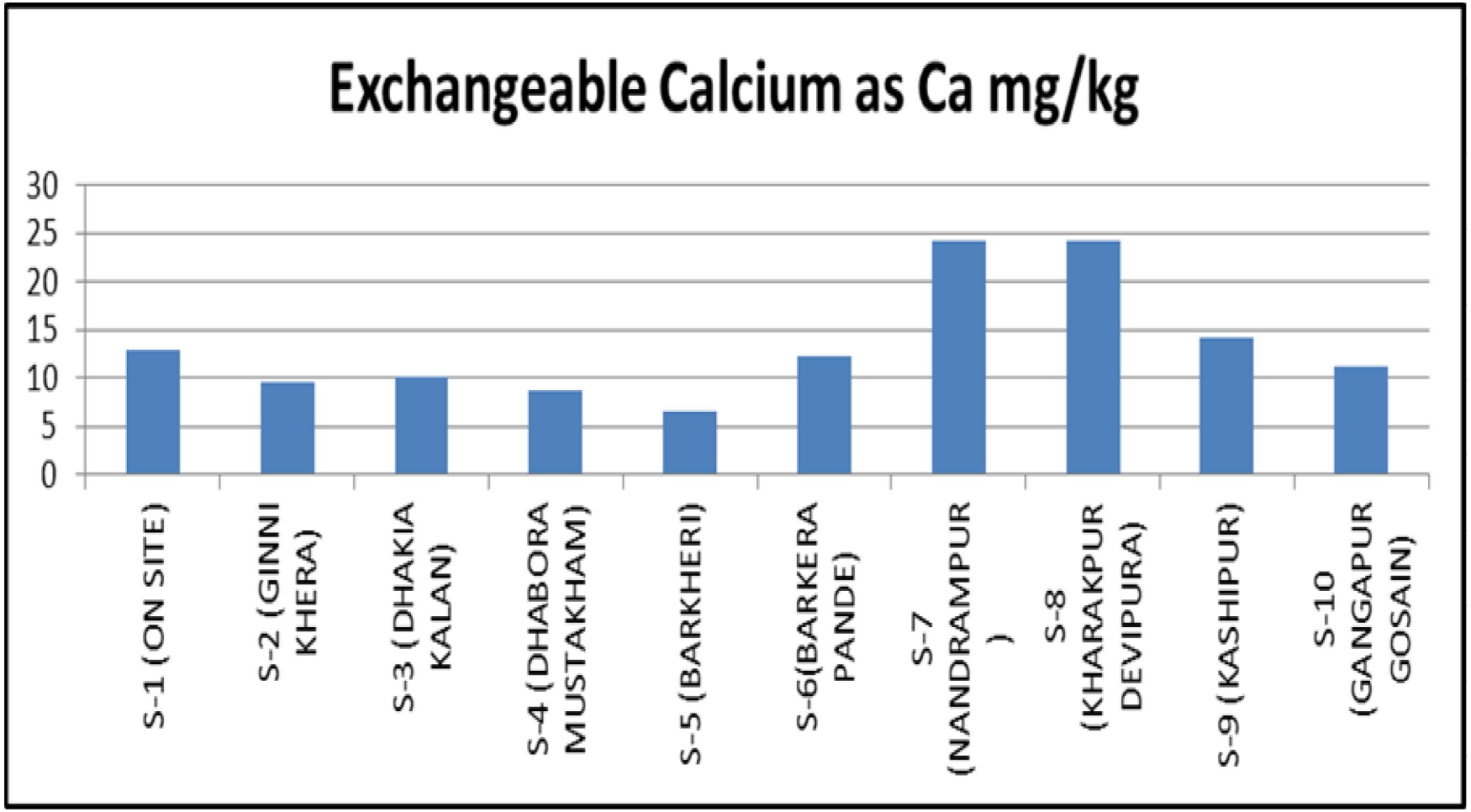


**FIGURE 33: COMPREHENSIVE VALUE OF CHLORIDE IN SOIL SAMPLE OF 2011**

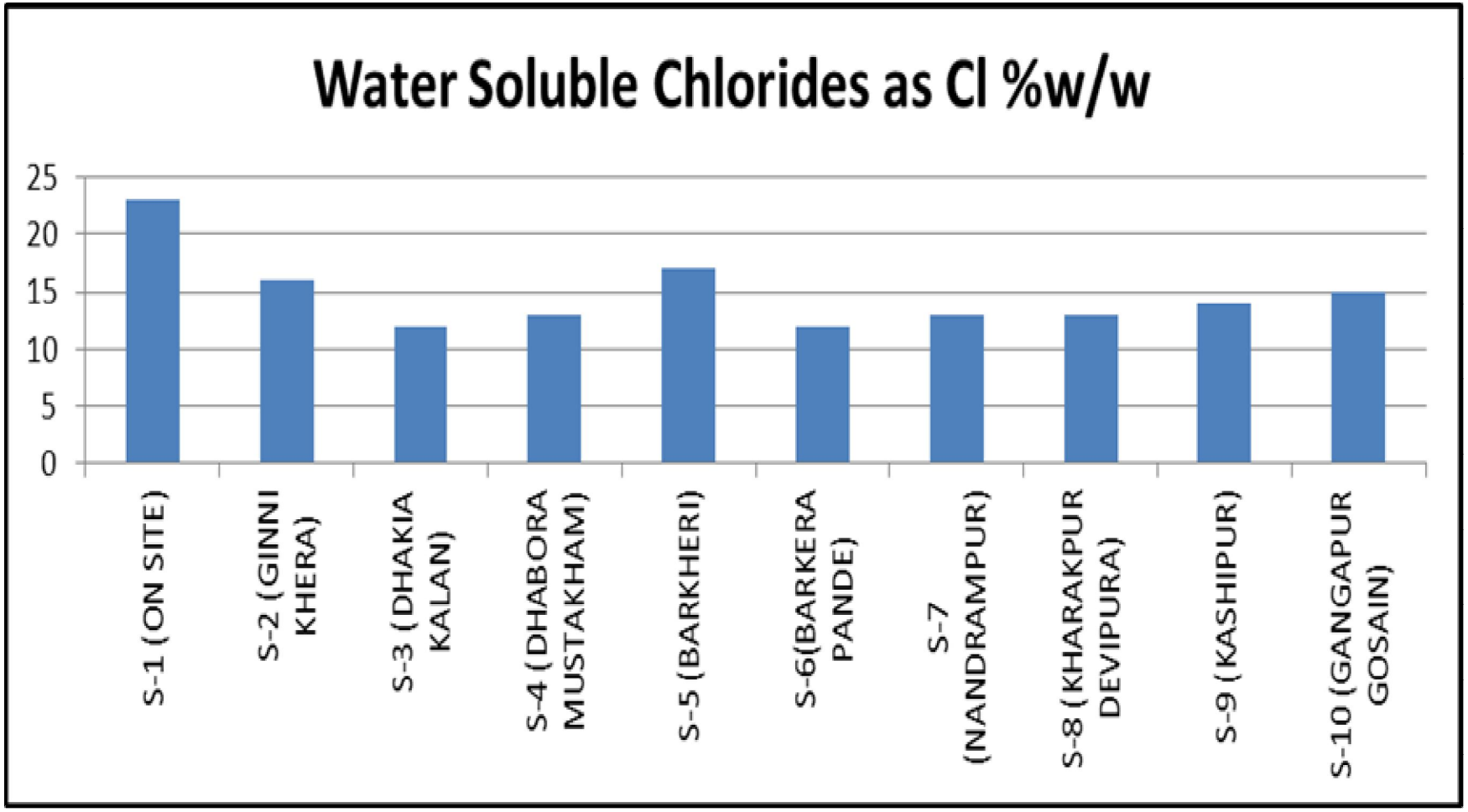
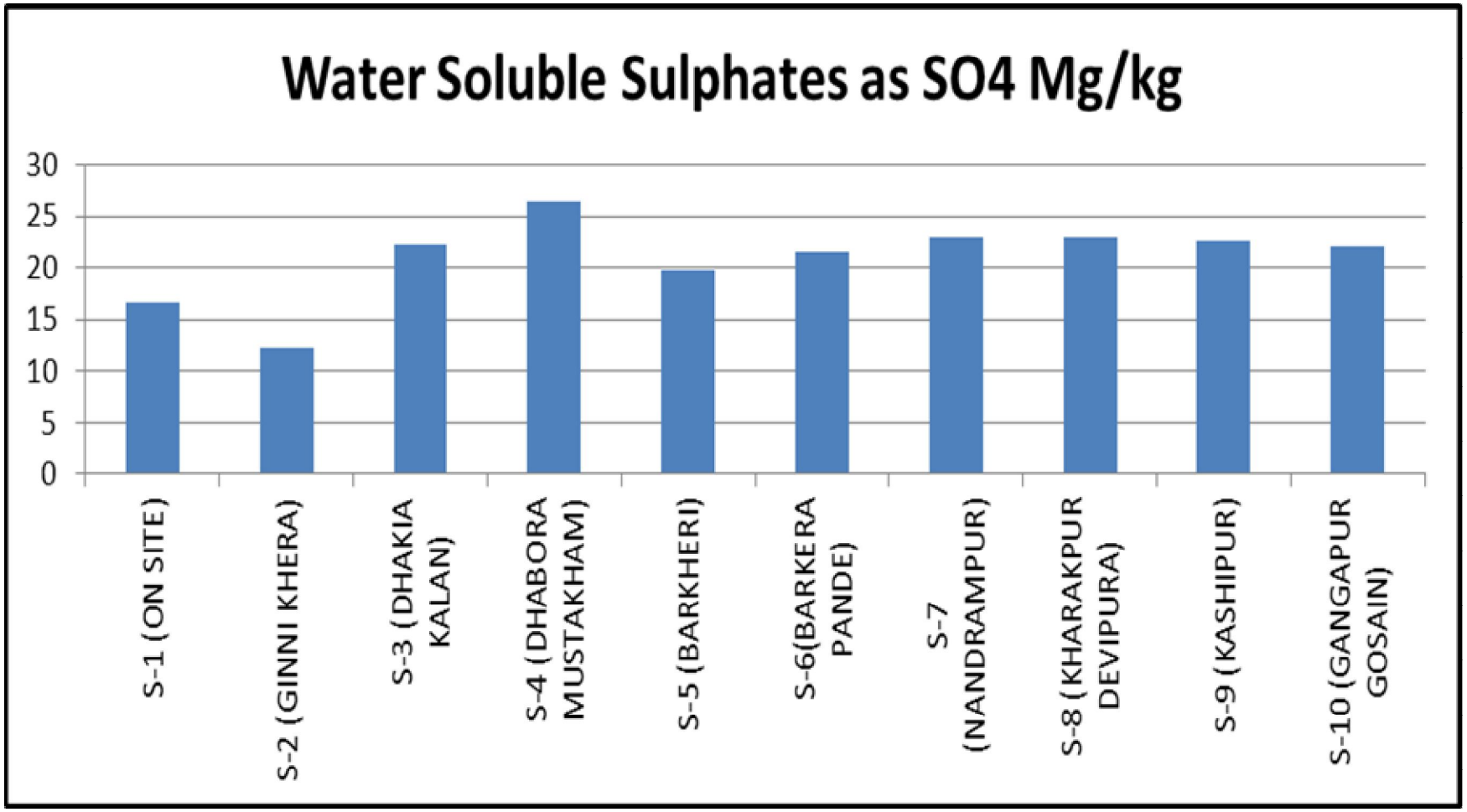


**FIGURE 34: COMPREHENSIVE VALUE OF SULPHATE IN SOIL SAMPLE OF 2011**



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