STUDY OF TEMPORAL VARIATION OF WATER QUALITY OF SATLUJ RIVER FROM 2012 TO 2017

Submitted by

JITIN VASUDEVA

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Under the Guidance of:-
Ms. Kirti Goyal
Assistant Professor

Submitted by:-
Jitin Vasudeva
Reg.no:- 41400014

LOVELY PROFESSIONAL UNIVERSITY
Phagwara-144401, Punjab (India)

DECLARATION

I, Jitin Vasudeva (Regd. No. 41400014), hereby declare that this dissertation report entitled "**STUDY OF TEMPORAL VARIATION OF WATER QUALITY OF SATLUJ RIVER FROM 2012 TO 2017**" submitted in the partial fulfillment of the requirements for the award of degree of Master of Technology in Environmental Engineering, in the School of Civil Engineering, Lovely Professional University, Phagwara, is my own work. This matter embodied in this report has not been submitted in part or full to any other university or institute for the award of any degree.

Date: 27-05-2017 Jitin Vasudeva

Place: Phagwara

CERTIFICATE

Certified that this project report entitled **"STUDY OF TEMPORAL VARIATION OF WATER QUALITY OF SATLUJ RIVER FROM 2012 TO 2017"** submitted by **"Jitin Vasudeva,** Reg. no**: 41400014"** student of Civil Engineering Department, Lovely Professional University, Phagwara, Punjab who carried out the dissertation work under my supervision.

This report has not been submitted to any other university or institution for the award of any degree.

Ms. Kirti Goyal
(Supervisor)

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ABSTRACT

Water is one of the vital needs of all living beings. Humans need water in many daily activities like drinking, washing, bathing etc. Water is the most important in shaping the land and regulating the climate. If the quality of water is not desirable then it becomes unfit for drinking and other activities. The quality of water is usually described according to its physical, chemical and biological characteristics. Hence it becomes necessary to find the suitability of water for various purposes like drinking, irrigation and Industrial purposes.

Rapid industrialization and use of chemical fertilizers and pesticides in agriculture are causing deterioration of water quality and depletion of aquatic biota. Due to use of contaminated water, human population suffers from various water borne diseases.

River pollution has been one of the main topics in the environmental issues of any country or state. The deteriorating water quality of rivers is of major concern in India; this is especially true for rivers being used as drinking water sources. One such river considered in this study is the River Satluj. A lot of water samples from different point sources of pollution were collected and tested for physico-chemical parameters (pH, temperature, DO, BOD, COD, TSS, TDS), metals (As, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) and microbiological parameter using World Health Organization (WHO) and the Bureau of Indian Standards (BIS) standards.

A water quality standard is a rule or law comprised of the uses to be made of a water body or segment and the water quality criteria necessary to protect that uses. Water quality was determined in the different stretches of the river Sutlej (S(1) and S(2)) for a period of nearly 6 years (2012 to 2017). S(1) was at U/S of Satluj River before Budha Nallah starts i.e. at just entering the Ludhiana city, S(2) was at 100 metres downstream of Confluence point where Buddha Nallah meets Satluj river at Walipur near Ludhiana. Relatively low values of TDS, turbidity, BOD, total alkalinity, total hardness, chlorides, nitrates, and phosphates were recorded at S(1) as compared to S(2). Heavy metals like Pb, Zn, Cr, and Ni were detected at S(2). On the basis of water quality standards given by Central Pollution Control Board, the water quality was at "B-C" at S(1), and "D-E" at S(2).The average temperature, concentration of pH, turbidity, TDS (Total Dissolved Solids), TSS(Total Suspended Solids), DO (Dissolved Oxygen), BOD (Biochemical Oxygen Demand), totalhardness, alkalinity and chloride are found to be 27.38 □C, 7.37, 2.438 NTU, 156.8 mg/l, 2.653mg/l, 42.156 mg/l, 3.6 mg/l, 8.65 mg/l, 102.3mg/l and 21.2 mg/l respectively. The results obtained from the water quality criteria parameter are within the drinking water standard (IS:10500).

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TERMINOLOGY

BIS	-	Bureau of India Standards
WHO	-	World Health Organization
DO	-	Dissolved Oxygen
BOD	-	Biochemical Oxygen Demand
COD	-	Chemical Oxygen Demand
TDS	-	Total Dissolved Solids
TSS	-	Total Suspended Solids
EDTA	-	Ethylene Diamine tetra Acetic Acid
EBT	-	Erichrome Black T
WQI	-	Water Quality Index
MPN	-	Most Probable Number
NTU	-	Nephelometric Turbidity Unit
EC	-	Electrical Conductivity
F. Coli	-	Faecal Coliform
TH	-	Total Hardness

CHAPTER -1

INTRODUCTION

Water is one of the basic needs of all human beings. Humans need water for daily activities like drinking, washing, bathing etc. Water is important for shaping the land and regulating the climate. If the quality of water is not desirable then it becomes unfit for drinking and other activities. The quality of water is usually described according to its physical, chemical and biological characteristics. Hence it becomes necessary to find the suitability of water for various purposes like drinking, irrigation and Industrial purposes.

Rapid industrialization and use of chemical fertilizers and pesticides in agriculture are causing deterioration of water quality and depletion of aquatic biota. Due to use of contaminated water, human population suffers from various water borne diseases.

India receives 4000 Km^3 of water through rainfall. Out of this 3/4 part occurs only during monsoon. The surface flow is estimated as 1880 Km^3. The annual replenishable groundwater resources are assessed to be about 600 Km^3 of which the annual usable resources are estimated at 420 Km^3. Inland water resources of the country are classified as rivers and canals; reservoirs; tanks and ponds; beels, oxbow lakes, derelict water; and brackish water. Other than rivers and canals, total water bodies cover an area of about 7 million hectare.

Punjab is the land of five rivers in northwest India and north-east Pakistan. Punj means "five" and aab means "waters", so "Punjab" means "land of five rivers". These five rivers that run through Punjab, having their originating source as various small lakes in Himalayas.

River pollution has been one of the main topics in the environmental issues of any country or state. The deteriorating water quality of rivers is of major concern in India; this is especially true for rivers being used as drinking water sources. One such river considered in this study is the River Satluj.

The Sutlej River is the longest of the five rivers that flow through the historic crossroads region of Punjab in northern India and Pakistan. The Sutlej River is also known as Satadree. It is the easternmost tributary of the Indus River.

The hydrology of the Sutlej is controlled by spring and summer snowmelt in the Himalayas and by the South Asian monsoon. The onset of the summer monsoon brings heavy rains that often produce extensive flooding downstream.

Freshwater is a finite resource, essential for agriculture, industry and even human existence. Without freshwater of adequate quantity and quality, sustainable development will not be possible. Water pollution and wasteful use of freshwater threaten development projects and make water treatment essential in order to produce safe drinking water. Discharge of toxic chemicals, over-pumping of aquifers, long-range atmospheric transport of pollutants and contamination of water bodies with substances that promote algal growth (possibly leading to eutrophication) are some of today's major causes of water quality degradation.

It has been demonstrated that water of good quality is crucial for sustainable socio-economic development i.e. causing no harm to environment. Aquatic ecosystems are threatened on a world-wide scale by a variety of pollutants as well as destructive land-use or water management practices. Some problems have been present for a long time but have only recently reached a critical level, while others are newly emerging. Gross organic pollution leads to disturbance of the oxygen balance and is often accompanied by severe pathogenic contamination. Accelerated eutrophication results from enrichment with nutrients from various origins, particularly domestic sewage, agricultural run-off and agro-industrial effluents. Lakes and impounded rivers are especially affected.

Agricultural land use without environmental safeguards to prevent over-application of agrochemicals is causing widespread deterioration of the soil/water ecosystem as well as the underlying aquifers. Direct contamination of surface waters with metals in discharges from mining, smelting and industrial manufacturing is a long-standing phenomenon. Today, there is trace contamination not only of surface waters but also of groundwater bodies, which are susceptible to leaching from waste dumps, mine tailings and industrial production sites.

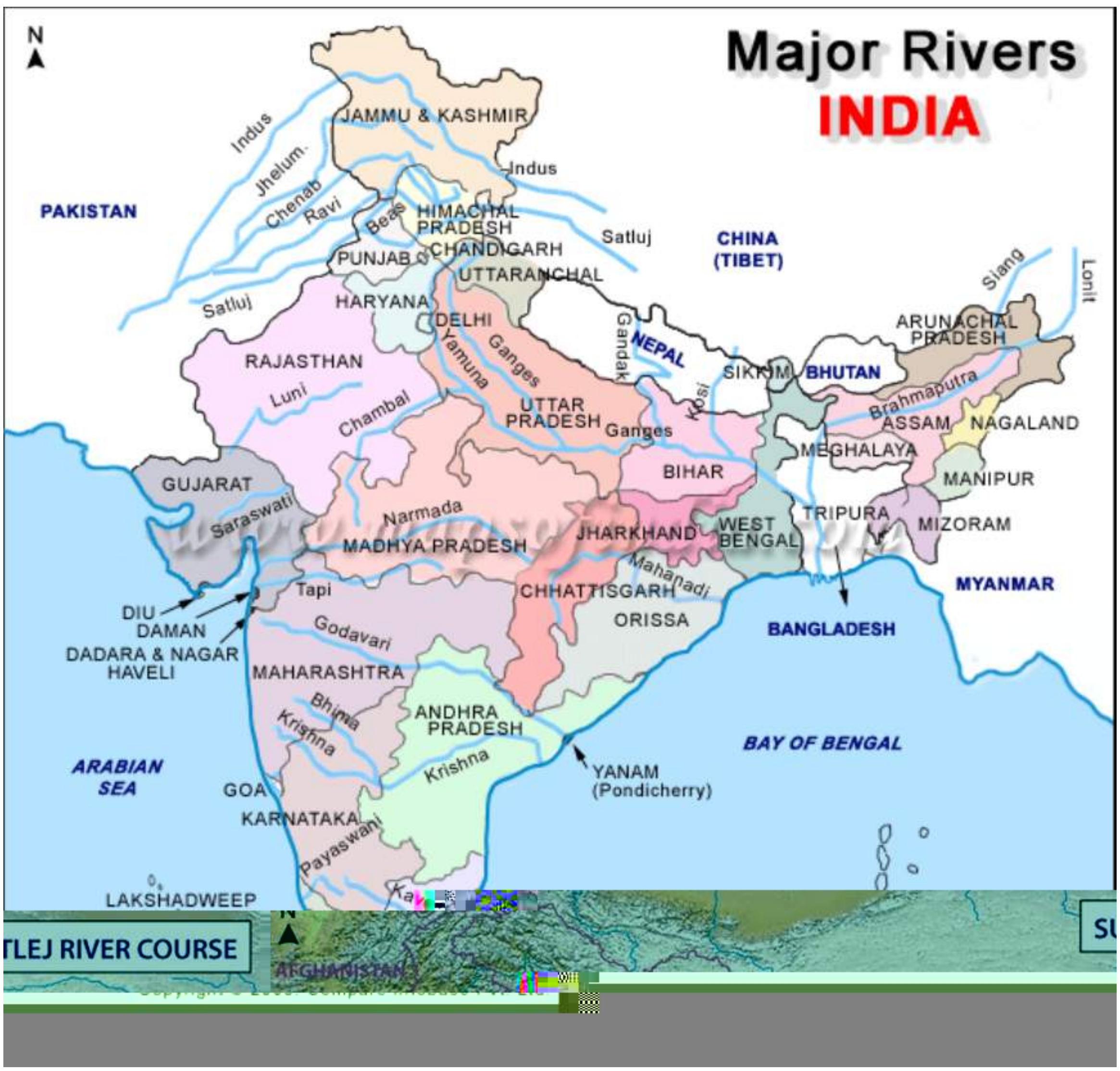
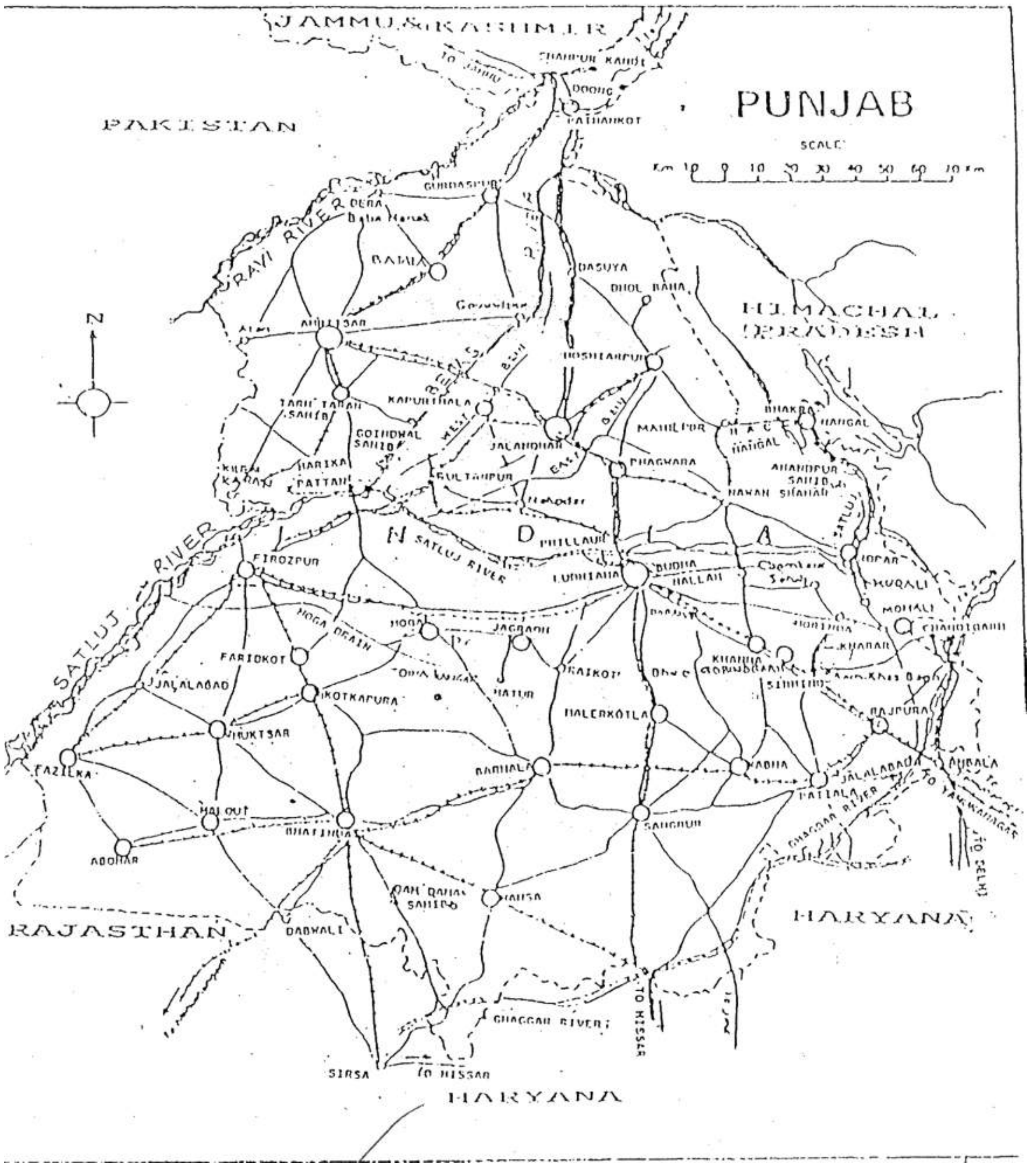


Fig 1 - MAP SHOWING MAJOR RIVERS IN INDIA

Fig 2 –MAP SHOWING SUTLEJ RIVER COURSE



<u>**Fig 3 - LAYOUT PLAN OF PUNJAB STATE**</u>

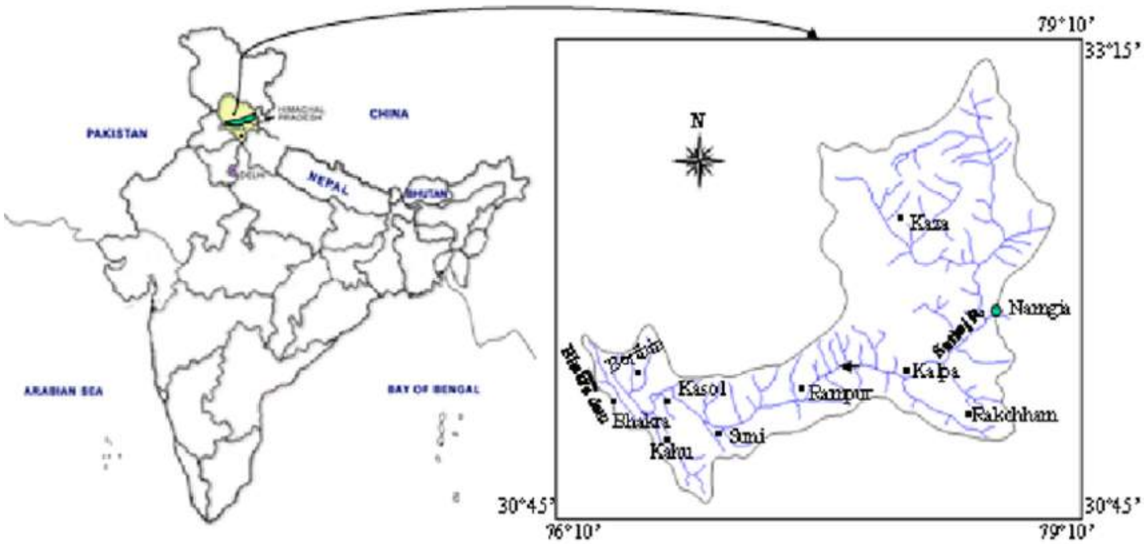


Fig 4 - MAP SHOWING SUTLEJ RIVER BASIN

Concept of Water Quality Management

The natural water bodies are used for various competing as well as conflicting purposes viz. drinking water source; religious bathing; propagation of wild life and fisheries; irrigation, industrial cooling and controlled waste disposal. The uses of rivers for various purposes require specific physiochemical and bacteriological characteristics. The ambient water in environment is not recommended to use directly for drinking purposes unless treated and disinfected by an organized water supply system. However for religious bathing, masses are advised to use specified stretches. The critical parameters for maintenance of water quality with respect to public health are coliform group of bacteria and organic matter. Thus the organic matter in terms of Biochemical Oxygen Demand is the most critical parameter representing municipal sewage pollution and industrial pollution from agro based industries. The organised water supplies with high organic matter in ambient water may cause formation of chlorinated compounds in the process of disinfection using chlorine. The presence of high organic matter from municipal origin accounts for higher number of coliform group of bacteria including faecal coliforms.

Therefore the need for water quality management in river is broadly concentrated on control of organic matter (in terms of BOD) by providing infrastructure for sewage treatment as first priority. Other aspects of water quality management from inorganic components of geogenic nature as well as water quality degradation due to effluents discharged by specific group of industrial sources will be addressed selectively.

The rivers in its entire length are not polluted and generally meet the water quality criteria for various beneficial uses. Water quality degradation is observed after large scale abstraction and point source of waste water disposal from municipal areas and industrial establishments.

The water quality monitoring over the years provided information on river stretches having higher concentration of BOD and are identified as polluted. The water quality deterioration of aquatic resources is a matter of concern, as it affects public health and aquatic life. Therefore corrective actions are required to be taken to prevent and control pollution in the identified polluted stretches.

This paper explains how water quality measurement is done in terms of various parameters and what its effects are.

BACKGROUND AND NEED OF STUDY

The Sutlej is the easternmost tributary of the Indus River. The hydrology of the Sutlej is controlled by spring and summer snowmelt in the Himalayas and by the South Asian monsoon. The onset of the summer monsoon brings heavy rains that often produce extensive flooding downstream. The river Sutlej was used as drinking water source by almost 50% of the state directly. There was significant human settlement along the river course throughout the state. With changing time, modernization and human tendency of moving towards cities have led to changes in past decade or so. The natural ecosystem/environment has been disturbed by various human activities, namely:-

1. **Deforestation and loss of natural habitats including wetlands** - source of abundant goods and services for society - for urban, industrial or agricultural use. This reduces natural flood control and destroys the habitats used by fish, water birds and many other species for breeding, feeding and migrating.

2. **Excessive water abstraction for agricultural irrigation, domestic consumption and urban/industrial use -** This may involve pumping too much water from underground supplies, or long distance transfers of water from one basin to a neighboring river basin. In both cases, the result has often been the same story of dried-up river beds and wetlands irreparable damage to wildlife, and failure to deliver overall economic benefits. Sadly, the ecological and economic value of freshwater systems damaged or destroyed by such 'technical fixes' is seldom taken properly into account.

3. **Pollution** caused by runoff from agricultural chemicals, poorly-managed and sometimes out-of-date industrial processes, and lack of adequate treatment for sewage and other urban waste. The results may include water that is unfit to drink, massive fish kills, and complete loss of underwater plants. Yet many effects of pollution are more insidious, only becoming clear after toxic substances have been building up in the food chain for many years.

All the pollutants, discharges like domestic sewage, untreated industrial wastewater, runoff from agricultural fields reaching the river has caused severe pollution in rivers and making the water quality reaching alarming levels.

The particular case of Sutlej river water quality deterioration is the mixing of Buddha Nallah in Ludhiana city. It contains domestic sewage discharges, untreated wastes from various industries, mainly textile and dyeing industries, discharge from dairy industries. All these discharges deteriorate the water quality and make it unfit for use for various purposes.

A pressing need has emerged for comprehensive and accurate assessments of trends in water quality, in order to raise awareness of the urgent need to address the consequences of present and future threats of contamination and to provide a basis for action at all levels. Reliable monitoring data are the indispensable basis for such assessments.

Monitoring is defined by the International Organization for Standardization (ISO) as: “the programmed process of sampling, measurement and subsequent recording or signaling, or both, of various water characteristics, often with the aim of assessing conformity to specified objectives”. This general definition can be differentiated into three types of monitoring activities that distinguish between long-term, short-term and continuous monitoring programmes as follows:

- Monitoring is the long-term, standardized measurement and observation of the aquatic environment in order to define status and trends.
- Surveys are finite duration, intensive programmes to measure and observe the quality of the aquatic environment for a specific purpose.
- Surveillance is continuous, specific measurement and observation for the purpose of water quality management and operational activities.

This study has been undertaken to check the water quality trends of river Sutlej and impact of Buddha Nallah in terms of various parameters just before the impact of Buddha Nallah starts i.e. Upstream of Buddha Nallah confluence point and 100 metres downstream of confluence point of Budhha Nallah and Sutlej.

OBJECTIVE AND SCOPE OF STUDY

With the current water crises in India, there is a dire necessity to conserve our rivers and ensure better water quality waters not only for our survival but also for maintaining community sustainability.

This Research aims at :-

1) DEFINING VARIOUS WATER QUALITY PARAMETERS.

2) CHECKING VARIOUS WATER QUALITY PARAMETERS OF SUTLEJ RIVER WATER AT UPSTREAM AND DOWNSTREAM OF LUDHIANA DISTRICT.

3) CHECKING AND DEFINING THE PERCENTAGE DEGRADATION OCCURRED IN SUTLEJ RIVER WATER OVER THE LAST FIVE YEARS.

VARIOUS PARAMETERS ARE :-

A) pH
B) Temperature
C) DO
D) COD
E) BOD
F) F.COLI

The scope of study includes but is not limited to:-

a. Monitoring and assessment of water quality of the river Sutlej.
b. With the help of survey, up to date and current knowledge of the present scenario of river Sutlej will be obtained.
c. Finding the causes of pollution in the river.
d. Suggesting measures for eradication of causes of the pollution.
e. Management of wastewater flowing into the river will reduce or eliminate adverse impact on the river and thereby supporting economic development and improved quality of life.
f. The proposal for use of such discharged water after treatment for various uses like for gardening, flushing toilets, laundry etc.

Chapter -2

LITERATURE REVIEW

Freeze and Cherry (1979) studied water chemistry in combination with groundwater hydraulics and river pollution.

Stumn and Morgan (1981) introduced many innovative ideas on water chemistry and its relation to its geological environment.

Geochemical studies of waters have been utilised to help define the hydrology of an area (**Konhauser** et al 1994). For example, the Amazon River waters were examined geochemically and the controlling factor on the water chemistry were determined to be substrate lithlogy and soil geochemistry of the erosion regime.

WQI is desired to provide assessment of water quality trends for management purposes even though it is not meant especially as an absolute measure of the degree of pollution or the actual water quality (Anonymous 1997).

Elango et al (1999) carried out hydro-geochemical studies in an intensively cultivated region of Tamil Nadu, India, and stressed the importance of regular monitoring of water quality parameters.

The correlationships among the numerous parameters facilitate the task of rapid monitoring of the status of pollution in that area (Kanan and Rajashekharan 1991, Shrivastava 1991) and may prove to be a boon in India and other developing countries where the laboratory facilities and trained manpower are inadequate.

Indirect methods to study source contributions of pollutant loads are essential to control water quality degradation in rivers. Especially in the rivers draining large basins, the application of direct methods/collection of data will be a major constraint (Sekhar 2001).

Manoj and Singh (2005) presented a research work on the prediction of mine water quality by physical parameters. Their paper was an attempt to32 predict the chemical parameters like sulphate, chlorine, chemical oxygen demand, total dissolved solids and total suspended solids in mine water using ANN by incorporating the pH, temperature and hardness. The prediction by ANN is also compared with Multivariate Regression Analysis (MVRA). For prediction of chemical parameters of mine water, 30 data sets were taken for the training of the network while testing and validation of network was done by 10 data sets with 923 epochs. The predicted results of the chemical parameters of mine water by ANN are very satisfactory and acceptable as compared to MVRA, and seem to be a good alternative for pollutants prediction.

R.Jindal and Chetan Sharma in their study namely "Studies on water quality of River Sutlej with reference to physicochemical parameters" have stated that the water quality was determined in the different stretches of the river Sutlej (S1, S2 and S3) for a period of 1 year

(November 2006 to October 2007). S_1 was at Ropar Head Works, S_2at U/S of Budha Nallah at Phillaur and S_3 was D/S of Budha Nallah in District Ludhiana (Punjab). Relatively low values of TDS, turbidity, BOD, total alkalinity, total hardness, chlorides nitrates, and phosphates were recorded at S_1 and S_2 as compared to S_3. Heavy metals like Pb, Zn, Cr and Ni were detected at S_2 and S_3. On the basis of water quality standards given by Central Pollution Control Board, the water quality was at "A-B" at S_1, "B-C" at S_2 and "D-E" at S_3. For the computation of water quality rating and water quality index, nine parameters were considered. The mean values of these parameters were compared with WHO, ICMR and ISI standards. The water quality index at stations S_1, $S_2$and S_3 was 32.84, 51.01 and 132.66 respectively. This clearly indicated that the river water at station S_2 and S_3 was found to be unsafe for human consumption.

From the very dawn of human civilization, with the unplanned rapid urbanization and industrialization, aquatic resources are being used as dumping grounds for sewage, industrial and technological wastes, with an idea that vast column of water through dilution and by the action of many detoxifying agents would make the toxic agents in noxious. The deteriorating water quality affects man, animals and plant life with far-reaching consequences. In India, due to tremendous urbanization and industrialization, the problem of water pollution has assumed an alarming situation and about 70% rivers in India are polluted. In the last few decades, there has been increasingly greater emphasis on the deterioration of water quality of Indian rivers. Pollution of a river first affects its physicochemical characteristics then systematically destroys the community, thus disturbing the delicate food web and is also hazardous to the public health. Diverse uses of rivers are seriously impaired due to increased pollution. Therefore, it has become important to assess immediately water quality of rivers.

Rene and Saidutta (2008) made their study on the title prediction of water quality indices by regression analysis and ANNs. The various waste water parameters such as TSS, BOD, COD, TOC, and phenolconcentration, Alkali Metal Nitrite (AMN), and TDS were obtained from the quality control laboratory of a refinery located in Mangalore, India. Water samples collected from the effluent treatment plant after tertiary treatment were analysed for the parameters considered. Regression analysis for the given data set was carried out using Microsoft Excel and their performance was indicated. The empirical relations developed in this study and the developed ANN based models can be applied with high degree of confidence for refinery wastewater.

STATUS OF WATERQUALITY IN INDIA- 2009
STUDY BY CENTRAL POLLUTION CONTROL BOARD (CPCB)

The report of Central Pollution Control Board states that:-

The water quality data of water bodies in the country forms the basis of management and planning of control of water pollution. The water quality data on rivers, lakes, ponds, tanks and groundwater locations being monitored under the network is evaluated against the water quality criteria and the monitoring locations in exceedence with respect to one or more parameters are identifiedas polluted and require action for restoration of water quality.

The monitoring results obtained during 2009 indicate that organic pollution continues to be the predominant pollution of aquatic resources. The organic pollution measured in terms of bio-chemical oxygen demand (BOD) & Coliform bacterial count gives the indication of extent of water quality degradation in different parts of our country. It is observed that nearly 64% of the observations are having BOD less than 3 mg/l, 19% between 3-6 mg/l & 17% above 6 mg/l. Similarly Total & Faecal coliform which indicate presence of pathogens in water are also a major concern. About 49% observations are having Total Coliforms and 70% observations are having Faecal Coliform less than 500 MPN /100 ml.

The water quality monitoring is performed with following main objectives in mind:-

- Rational planning of pollution control strategies and their prioritization;
- To assess nature and extent of pollution control needed in different water bodies or their part;
- To evaluate effectiveness of pollution control measures already in existence;
- To evaluate water quality trend over a period of time;
- To assess assimilative capacity of a water body thereby reducing cost on pollution control;
- To understand the environmental fate of different pollutants.
- To assess the fitness of water for different uses.

The Central Pollution Control Board (CPCB) has established a network of monitoring stations on rivers across India.

The water samples are analyzed for 9 core parameters and 19 general parameters. The monitoring agencies have also analyzed the trace metals at few locations. The list of parameters is tabulated below:-

1. pH
2. Temperature
3. BOD
4. F-Coli
5. Turbidity
6. COD
7. TKN
8. Hardness
9. TDS
10. Sulphates
11. Lead
12. Chromium etc.

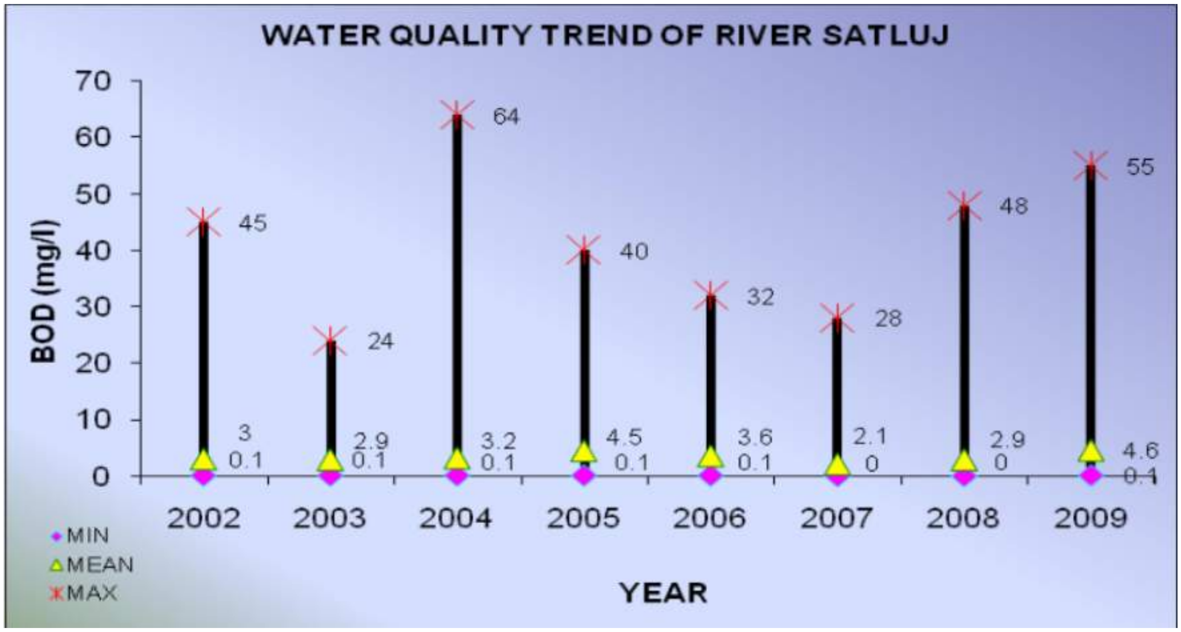


Fig 5 – WATER QUALITY TREND OF BOD IN RIVER SUTLEJ

The monitoring results obtained during 2009 under National Water Quality Monitoring Programme (NWQMP) reflect that organic matter & bacterial population of faecal origin continue to dominate the water pollution problem in India. The major water quality concerns as revealed from the monitoring results are pathogenic pollution as reflected through indicators i.e. Total Coliforms (TC) & Faecal Coliform (FC), organic matter as reflected through Biochemical Oxygen Demand (BOD) and salinity as reflected through conductivity.

Table-1 showing Designated-Best-Use (DBU) as defined by CPCB

Designated-Best-Use	Class of Water	Criteria
Drinking Water source without conventional treatment but after disinfection	A	1. T.Coli 50 or less 2. pH 6.5 to 8.5 3. DO 6mg/l or more 4. BOD 5 days 20^{o}C 2mg/l or less
Outdoor bathing (Organised)	B	1. T.Coli 500 or less 2. pH 6.5 to 8.5 3. DO 5mg/l or more 4. BOD 5 days 20^{o}C 3mg/l or less
Drinking water source After conventional Treatment and Disinfection	C	1. T.Coli 5000 or less 2. pH 6to 9 3. DO 4mg/l or more 4. BOD 5 days 20^{o}C 3mg/l or less
Propagation of wildlife and Fisheries	D	1. pH 6.5to 6.5 2. DO 4mg/l or more 3. Free ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	1. pH between 6.0 to 8.5 2. Electrical Conductivity at 25oC micro mhos/cmMax.2250 3. Sodium absorption Ratio Max. 26 4. Boron Max. 2mg/l

Xiaoying Liu from China Institute of Water Resources and HydropowerResearchin his study "Zoning of rural water conservation in China: A case study at Ashihe River Basin" states that the water supply quantity and quality are fundamental issues globally; they not only concern the sustainable development of the economy, but also directly affect the human living environment. Water shortages and severe water pollution are two of the most important environmental problems in China, especially in rural areas. Rural industries have prospered since the economic reform in 1978, which have become one of the driving forces of rapid economic growth, but they consume massive quantities of the water resource and simultaneously pollute aquifers and water bodies.

The various methods are:-

1. Zoning index system

2. Zoning methods

3. The agricultural NPS pollution loads method

As the zoning of rural water conservation was implemented at the province and city level, a more specific region should be investigated to test the effectiveness of the zoning methods. Thus, the agricultural NPS pollution load was identified by the equal standard pollution load and equal standard pollution load ratio methods in Ashihe watershed, which is in the Songhua River Basin. According to the third level zoning, the Ashihe watershed is moderate pollution from agriculture and livestock. In the study of agricultural NPS pollution, the pollution indicators include COD, TN, TP, and the main pollution sources are from fertilizer, livestock, living waste, straw and soil erosion in Ashihe watershed.

According to the calculation results of the discharge of pollutants from pollution sources and their equal standard pollution loads in Ashihe watershed in 2011, there were a large quantity of agriculture NPS pollutants discharged into water bodies, the discharge amount of COD, TN, TP were as much as 7052.8 t, 3370.28 t, and 590.02 t, respectively. Their equal standard pollution loads were 352.64×106 m3 /yr, 3370.44×106 m3/ yr, 2606.86×106 m3/ yr, and the equal standard pollution load ratios were 5.57%, 53.25% and 41.18%, which meant the main pollutants were TN and TP.

He Concluded that:-

A zoning index system of rural water conservation is established in this paper. The zoning methods of the three levels are built and the first level zoning results are preliminarily analyzed. Based on a case study in Ashihe watershed, the effectiveness of the zoning method is demonstrated with a consistent result of a local situation.

On the basis of one-dimensional Euclidean distance and the four natural realms, a first level of zones has 9 sub-zones according to similarity of water resources, most of which are composed of provinces, some cities are adjusted according to water use efficiency. Moreover, on the basis of pollution types and intensities of cities, the first-level zones are divided into 25 second-level zones, which are further divided into 70 third-level zones.

The zoning results can be used to guide rural water conservation at the regional and provincial level, which is a very effective way to control rural pollution not only in China but also a good guide to controlling water pollution in other parts of the world. Based on pollution types and intensities, suitable management goals and measures can be established to control and mitigate water pollution in rural areas. For example, based on the second and third zoning, the inventory of the whole and common NPS pollution control technology systems can be established according to pollution type and intensity in certain zone and its technology demonstration zones can be established to show its effectiveness to all stakeholders for use. Moreover, the management experience and technologies can also be applied to similar regions, based on Zoning Conformance.

Wiley-Blackwell concluded in his research paper **"River Conservation and Water Management"** that four broad topics are necessary for river quality conservation:-

- **Catchment management, ecosystem integrity and the threats to river ecosystems** – This covers progress on understanding and addressing the pressures affecting rivers, many of which will be amplified by climate change and increasing human demands for water;
- **Methods and approaches**– illustrating some recent techniques that have been developed to assess condition and conservation status across different types of river;
- **Recovery and rehabilitation**– providing an insight into the principles, practice, public involvement and institutional networks that support and make improvements to modified river reaches;
- **Integrating nature conservation into wider river management** –demonstrating the importance of integrated planning, involvement of local communities and the use of adaptive management in achieving multiple environmental and economic benefits along rivers used for different purposes.

Firozia Naseema Jalal and M.G. Sanalkumar study namely "Hydrology and Water Quality Assessment of Achencovil River in Relation to Pilgrimage Season" deals with assessment of the waterquality of the River Achencovil Sabarimala is the largest annual pilgrimage in India with an estimated 45–50 million devotees visiting every year. The Achencovil River is a small river not more than 130 kilometers. Pilgrims use the water of Achencovil River for various sanitary purposes. The water quality is also disturbed by various other anthropogenic activities by the population living near the river. The microbiological and physico-chemical characteristics were studied and analyzed during July 2010–April 2011using standard procedures. The mid-streampart of the river is selected for the study. The results revealed that all the studied sites showed more pollution during the pilgrimage season (postmonsoon) than the off seasons (monsoon and summer) and also showed fluctuations in microbiological and physico-chemical parameters. Pollution of river water can be reduced by providing proper sanitation facility to pilgrims and by providing proper methods for dumping of sewage and wastes. Almost all parameters showed significant ($P<0.05$) seasonal variation between segments and was determined by ANOVA.

They emphasized on following:-

Physico-chemical analysis

Temperature: In the present investigation the temperature showed drastic difference at all the sites in all the seasons. The temperature was high during summer i.e. before Sabarimala pilgrimages season and least during post monsoon i.e. during Sabarimala pilgrimage season and it was after a long monsoon period. In the present study, water temperature ranged from 25.5oC to 35.4 oC at various study sites. Temperature is an important physical parameter of water quality which has a direct effect on aquatic life as because it reduces the dissolved oxygen (DO) concentration in the water making oxygen less available for respiration. Temperature controls behavioral characteristics of organisms, solubility of gases and salts in water (P.S Welch,1992). Temperature also affects chemical reactions and reaction rates within the water, thereby influencing its suitability for use (Metcalf and Eddy, 2003). The marked temperature difference in four season showed high anthropogenic disturbances.

Free Carbon Dioxide (CO2): The free CO2was high during summer in almost all segments. Before the pilgrimage season (monsoon season) and during the pilgrimage season (post monsoon) the value is between 0.8ml/L and 1.2 ml/L in all the sites. The free CO2value for all the sites after the pilgrimage season (summer) ranges between 1.11ml/L and 1.29 ml/L. Similar works were done by Kauret al,2000 in Kanjili wetland. The amount of carbon dioxide determines the pH of water.

Conductivity (EC) And Total Dissolved Solids (TDS): Electrical conductivity (EC) is a measure of the ions present in water, and therefore a surrogate for total dissolved solids (TDS). The conductivity values in the water samples ranged from 0.031ds/m (Summer, S4) to 0.037 ds/m (Monsoon, S2). The maximum value in the monsoon season indicates the presence of ions in the water. The TDS values in the water samples varied from 20.3 mg/L (Summer, S4) to 26.5 mg/L (Monsoon,S6). The EC and TDS of the water samples were with the permissible limit as prescribed by WHO i.e. EC of 0.7 dS/m (700 mS/cm) and a TDS concentration of less than 450 mg/L. The Physico-chemical features of river showed moderate to adequate levels of parameters. Sohani et al., (2002), Kulkarni et al., (2001), Sakhare and Joshi (2003), Trevedi and Gupta (1995), Tamlurkar and Ambore (2006) have carried exhaustive study on physicochemical characteristics of water. Similar works were carried out by Dulo et al., 2008 in Nairobi River, Kenya, Joseph et al ., 2010 in Pennar River of Kerala, India, Yadav et al ., 2011 in Kosi River of Rampur District, Uttar Pradesh, Sharma Shraddha et al.,2001 in Narmada River. The seasonal variation in water temperature, pH, Dissolved Oxygen and Free Carbon dioxide Conductivity EC And Total Dissolved Solids TDS were statistically significant ($P<0.05$).

CONCLUSION AND RECOMMENDATION:-

In conclusion, the water of Achencovil River is highly contaminated especially during Sabarimala pilgrimage season than the off season because pilgrims use the river water for various sanitary purposes. From this study it was revealed that deterioration of quality of water was very high at Pandalam during all the studied seasons. This is due to high anthropogenic disturbances associated with Sabarimala pilgrimage. Among the different studied seasons, monsoon season showed improved water quality. Uncontrolled use of chemical fertilizers and pesticides, unscrupulous dumping of domestic wastes are also the major causes of deterioration of water. Pollution of river water can be reduced by providing proper sanitation facility to pilgrims and also by providing proper methods for dumping of municipal sewage, domestic wastes etc. The quality of water is depleting rapidly with the change in human life style i.e., massive industrialization, construction activities, utilization of agricultural land and forest land for other developmental purposes. It is evident that water borne diseases are due to improper disposal of refuse, contamination of water by sewage, surface runoff, therefore programme must be organized to educate the general populace on the proper disposal of refuse, treatment of sewage and the need to purify our water to make it fit for drinking because the associable organisms are of public health significance.

In India, pioneering studies on limnology of river and lake ecosystems were carried out by Chakrabarty et al. (1959) on River Yamuna, David (1963) on river Gandak, Ray et al. (1966)on river Ganga and Yamuna, Pahwa and Mehrotra (1966) on river Ganga, Vyas (1968) on Pichhola lake, Udaipur and David et al. (1969) on Tungabhadra reservoir, John (1978) on the river Kallayi, Kerala, Raina et al. (1984) on river Jhelum, Tiwari et al. (1986) on river Jhelumand (1988) on river Subarnarekha, Qadri et al. (1993) on river Ganga, Das et al. (1994) on riverGanga, Hosetti et al. (1994) on Jayanthinalla and river Panchaganga at Kolhapur, Rao et al.(1994) on Ooty lake, Murugesan et al. (1994) on river Tampraparani, Chaurasia (1994) on river Mondakini, Mishra et al. (1994) on river Subarnarekha, Mitra et al. (1995) on river Mahanadi, Choubey (1995) on river Tawa , Desai (1995) on river Dudhsagar and Khandepar river, Katariaet al. (1995) on river Kubza, Chandra et al. (1996) on river Ramaganga, Lal (1996) on Pushkar Sarovar, Banerjee et al. (1999) on river Tikaraand Brahmani, Gambhi (1999) on Maithon Reservoir, Jain (1999) on Khnop Reservoir, Koshy et al. (1999 and 2000) on river Pamba, Bhuvaneswaran et al. (1999) on river Adyar, Patel (1999) on Pitamahal Dam, Sharma et al.(1999) on river Yamuna, Singh et al. (1999) on River Damodar, Gyananath et al. (2000) on river Godavari, Kausik et al. (2000) on river Ghaggar, Chatterjee et al. (2001) on river Nunia in Asansol, West Bengal, Kaur et al. (2001) on river Sutlej, Garg et al. (2002) on western Yamuna canal from Tajewala (Haryana) to Haiderpur treatment plant (Delhi), Abbasi et al. (2002) on Buckinghhum canal, Martin et al.(2003) on river Tamiraparani, Srivastava et al. (2003) on river Gaur at Jabalpur, Sinha et al. (2004) on river Ram Ganga, Singh et al. (2004) on river Yamuna and Guru Prasad et al. (2004) on Sarada river basin.

Table -2 showing drinking water standards

Sl. No.	Parameters	Permissible value	Standard
1.	Color	Unobjectionable	IS: 10500
2.	Taste	Agreeable	IS: 10500
3.	pH	6.5-7.5	IS: 10500
4.	Turbidity (Max NTU)	5	IS: 10500
5.	TDS	500	IS: 10500
6.	TSS	5	USPHS
7.	BOD	Nil to 5	USPHS
8.	DO	4.0 to 6.0	USPHS
9.	Total hardness	300	IS: 10500
10.	Chloride	250	IS: 10500
11.	Alkalinity	120	USPHS
12.	Residual chlorine	0.2	IS: 10500

(Except pH and turbidity other parameters are in mg/l)
USPHS stands for United States Public Health Service.

Table 3- PPCB Parameters

S No	Parameters / Pollutants	Values
i)	Temperature	Shall not exceed 5^0c above the receiving water temperature
ii)	pH	5.5-9.0
iii)	Biochemical Oxygen Demand (as BOD5) at 20^0c	≤10 mg/l
iv)	COD	≤50 mg/l
v)	Total Suspended Solids	≤10 mg/l
vi)	Fecal Coliforms	≤230 MPN/100 ml
vii)	TotalKjeldahl Nitrogen (as N)	≤50 mg/l
viii)	Ammonical Nitrogen – as (N)	≤20 mg/l
ix)	Total Phosphorous	≤2 mg/l
x)	Sulphate	≤200 mg/l
xi)	SAR	≤3.5
xii)	EC	≤ 2000 us/cm
xiii)	RSC	≤2.5mg/l

Chapter -3

MATERIAL AND METHODOLOGY

1. Physical, chemical and biological tests of local water bodies (Sutlej River): Various tests of the local water bodies will be conducted in the government laboratory under PHE at HMT. The tests will be conducted so that it becomes evident that water bodies are contaminated because of the direct discharge of wastewater into them. The tests will be conducted are mentioned below along with the procedure:

3.1 METHODOLOGY FOR THE MEASUREMENT OF pH Value

(ELECTROMERIC METHODS)

pH value is the logarithm of reciprocal of hydrogen ion activity in moles per liter. In water solution, variations in pH value from 7 are mainly due to hydrolysis of salts of strong bases and weak acids or vice verse. Dissolved gases such as carbon dioxide, hydrogen sulphide and ammonia also affect pH value of water. The overall pH value range of natural water is generally between 6 and 8. In case of alkaline thermal spring waters pH value may be more than 9 while for acidic thermal spring waters the pH may be 4 or even less than 4. Industrial wastes may be strongly acidic or basic and their effect on pH value of receiving water depends on the buffering capacity OY water. The pH value obtained in the laboratory may not be the same as that of water at the time of collection of samples due to loss-or absorption of gases, reactions with sediments, hydrolysis and oxidation or reduction taking place within the sample bottle. pH value should preferably be determined at the time of collection of sample. The pH value may be determined either electrometrically or calorimetrically. The electrometric method is more accurate but requires special apparatus. The calorimetric method is simple and requires less expensive apparatus, and is sufficiently accurate for general work. It is, however, subject to interference by color, turbidity, high saline content, free chlorine and various oxidants and reductants.

3.1.1 PRINCIPLE

The pH value is determined by measurement of the electromotive force of a cell consisting of an indicator electrode (an electrode responsive to hydrogen ions such as a glass electrode) immersed in the test solution and a reference electrode (usually mercury/calomel electrode), Contact between the test solution and the reference electrode is usually achieved by means of a liquid junction, which forms part of the reference electrode. The electromotive force is measured with a pH meter, that is, a high impedance voltmeter calibrated in terms of pH. 2.1.1 Several types of electrodes have been suggested for electrometric determination of pH value. Although the hydrogen gas electrode is recognized as primary standard the glass: electrode in combination with calomel electrode is generally used with reference potential provided by saturated calomel electrode. The glass electrode system is based on the fact that a change, of 1 pH unit produces an electrical change of 59.1 mV at 25°C. The active element of a glass electrode is a membrane of a special glass. The membrane forms a partition between two liquids of differing hydrogen ion concentration and a potential is produced between the two sides of the membrane which is proportional to the difference in pH between the liquids.

3.1.2 APPARATUS

1. pH meter - With glass and reference electrode (saturated calomel), preferably with temperature compensation.
2. Thermometer - With least Count Of 0.5°C.

3.1.3 SAMPLE HANDLING AND PRESERVATION

2. Samples should be analyzed as soon as possible, preferably in the field at the time of sampling.

3. High purity waters and waters not at equilibrium with the atmosphere (ground waters or lake waters collected at depth) are subject to changes when exposed to the atmosphere, Therefore the sample containers should be filled completely and kept sealed prior to analysis.

3.1.4 PROCEDURE

After required warm-tip period, standardize the instrument with a buffer solution of pH near that of the sample and check electrode against at least one additional buffer of different pH value. Measure the temperature of the water and if temperature compensation is available in the instruments adjust it accordingly. Rinse and gently wipe the electrodes with solution. If field measurements are being made, the electrodes may be immersed directly in the sample stream to an adequate depth and moved in a manner to ensure sufficient sample movement across the electrode sensing element as indicated by drift free readings (< 0.1 pH unit). If necessary, immerse them into the sample beaker or sample stream and stir at a constant rate to provide homogeneity and suspension of solids. Rate of stirring should minimize the air transfer rate at the air-water interface of the sample. Note and record sample pH and temperature However, if there is a continuous drift, take a second reading with the fresh aliquot of sample without stirring and report it as the pH value.

Fig 6 - pH Meter

3.2 METHODOLOGY FOR MEASUREMENT OF TEMPERATURE

3.2.1 PROCEDURE

a. Temperature was measured with the thermometer holding in the air for air temperature and immersed directly in the water body, after a period of time sufficient to permit constant reading.

b. Make measurement of the temperature of a water body at a particular depth with the thermometer immersed directly in the water body. After sufficient time has elapsed to allow the thermometer to come to the exact temperature of the water, take a reading.

Fig 7 – BOD INCUBATOR

3.3 METHODOLOGY FOR MEASUREMENT OF DO

3.3.1. APPARATUS

1. Incubation bottles
2. DO meter
3. Air incubator

3.3.2. PROCEDURE

After taking water in incubation bottle, it is kept in incubator and a magnetic stirrer is put inside the bottle. The magnetic stirrer continuously rotates inside the bottle. Then with the help of DO meter 3 readings have been noted, first reading has been taken at the bottom, second at mid point and third at top of the bottle. Now the average of the readings will give the dissolved oxygen present in the water sample.

3.4 METHODOLOGY FOR MEASUREMENT OF BOD

3.4.1 PRINCIPLE

The biochemical oxygen demand (BOD) test is based on mainly bio-assay procedure which measures the dissolved oxygen consumed by micro-organisms while assimilating and oxidizing the organic matter under aerobic conditions. The standard test condition includes incubating the sample in an air tight bottle, in dark at a specified temperature for specific time.

3.4.2 APPARATUS

i) Incubation Bottles

300 ml capacity narrow neck special BOD bottles with planed mouth with ground glass stoppers. New bottles should be cleaned with 5 N hydrochloric acid or sulphuric acid followed by rinsing with distilled water. In normal use, bottles once used for Winkler’s procedure should only be rinsed with tap water followed by distilled water. During incubation (if incubator is used) to ensure proper sealing, time to time, add water to the flared mouth of the bottle.

ii) Air Incubator

Air incubation with thermostatically controlled 27°C ± 1°C. Avoid light to prevent possibility of photosynthetic production of oxygen.

3.4.3 PROCEDURE

After taking water in incubation bottles, 4 capsules (or 4 gm) of NaOH has been kept at the neck of the bottle. A magnetic stirrer is put inside the bottle. The magnetic stirrer continuously rotates inside the bottle. Then it is kept air tight by the special caps attached with an electronic meter, which directly records BOD reading at every 24 hour. Now the bottles are preserved in the incubators for days as per requirement of study. The same procedure follows for BOD 3 days and BOD 5 days.

3.5 METHODOLOGY FOR MEASUREMENT OF COD

3.5.1 PRINCIPLE

The Chemical Oxygen Demand (COD) method determines the quantity of oxygen required to oxidize the organic matter in a waste sample, under specific conditions of oxidizing agent, temperature, and time. Since the test utilizes a specific chemical oxidation the result has no definite relationship to the Biochemical Oxygen Demand (BOD) of the waste or to the Total Organic Carbon (TOC) level. The test result should be considered as an independent measurement of organic matter in the sample, rather than as a substitute for the BOD or TOC test.

3.5.2 APPARATUS

Glassware should consist of a 500 mL Erlenmeyer flask or a 300 mL round bottom flask made of heat-resistant glass connected to a 12 inch Allihn condenser by means of a ground glass joint. Any equivalent reflex apparatus may be substituted provided that a ground-glass connection is used between the flask and the condenser.

3.5.3 PROCEDURE

1. Place several boiling stones in the reflux flask, followed by 50.0 mL of sample or an aliquot diluted to 50.0 mL and 1 g of $HgSO_4$ (6.5). Add 5.0 mL conc. H_2SO_4 (6.8); swirl until the mercuric sulfate has dissolved. Place reflux flask in an ice bath and slowly add, with swirling, 25.0 mL of 0.025 N $K_2Cr_2O_7$ (6.2). Now add 70 mL of sulfuric acid-silver sulfate solution (6.3) to the cooled reflux flask, again using slow addition with swirling motion. Caution: Care must be taken to assure that the contents of the flask are well mixed. If not, superheating may result, and the mixture may be blown out of the open end of the condenser.

2. If volatile organics are present in the sample, use an allihn condenser and add the sulfuric acid-silver sulfate solution through the condenser, while cooling the flask, to reduce loss by volatilization.

3. Apply heat to the flask and reflux for 2 hours. For some waste waters, the 2-hour reflux period is not necessary. The time required to give the maximum oxidation for a wastewater of constant or known composition may be determined and a shorter period of refluxing may be permissible.

4. Allow the flask to cool and wash down the condenser with about 25 mL of distilled water. If a round bottom flask has been used, transfer the mixture to a 500 mL Erlenmeyer flask, washing out the reflux flask 3 or 4 times with distilled water. Dilute the acid solution to about 300 mL with distilled water and allow the solution to cool to about room temperature. Add 8 to 10 drops of ferroin indicator (6.6) to the solution and titrate the excess dichromate with 0.25 N ferrous ammonium sulfate (6.4) solution to the end point. The color change will be sharp, changing from a blue-green to a reddish hue.

5. Blank-Simultaneously run a blank determination following the details given in (7.1) and (7.2), but using low COD water in place of sample.

Fig 8 – COD Apparatus

3.6 METHODOLOGY FOR MEASUREMENT OF F.COLI

Bacteria are the minute single cell organisms possessing no defined nucleous and having no green material to help them manufacture their own food. They can be harmless, known as non-pathogens or harmful, called as pathogens. They can cause harmful diseases like cholera, typhoid, infectious hepatitis, etc. We use microbiological analytical procedure which uses samples of water and from these samples determine the concentration of bacteria. It is then possible to draw inferences about the suitability of the water for use from these concentrations. This process is used, for example, to routinely confirm that water is safe for human consumption or that bathing and recreational waters are safe to use.

Plate count method can be used for the determination of pathogens in water sample. The plate count method relies on bacteria growing a colony on a nutrient medium so that the colony becomes visible to the naked eye and the number of colonies on a plate can be counted. To be effective, the dilution of the original sample must be arranged so that on average between 30 and 300 colonies of the target bacterium are grown. Fewer than 30 colonies makes the interpretation statistically unsound whilst greater than 300 colonies often results in overlapping colonies and imprecision in the count. To ensure that an appropriate number of colonies will be generated several dilutions are normally cultured.

The laboratory procedure involves making serial dilutions of the sample (1:10, 1:100, 1:1000, etc.) in sterile water and cultivating these on nutrient agar in a dish that is sealed and incubated. Typical media include plate count agar for a general count or MacConkey agar to count Gram-negative bacteria such as E. coli. Typically one set of plates is

incubated at 22°C and for 24 hours and a second set at 37°C for 24 hours. The composition of the nutrient usually includes reagents that resist the growth of non-target organisms and make the target organism easily identified, often by a color change in the medium. Some recent methods include a fluorescent agent so that counting of the colonies can be automated. At the end of the incubation period the colonies are counted by eye, a procedure that takes a few moments and does not require a microscope as the colonies are typically a few millimeters across.

RESEARCH METHODOLOGY

1) Collection of sample:-
   Firstly we will take samples from Sutlej river from upstream and downstream of Ludhiana city.

2) Analyzing :-
   The samples taken shall be subjected to testing for various parameters.

3) Results :-
   The results obtained after testing and analyzing shall be tabulated.

4) Determining:-
   The overall water quality of the river Sutlej shall be determined along with the percentage degradation over the last decade.

Fig 9 - CONFLUENCE OF BUDHA NALLAH WITH RIVER SUTLEJ AT WALIPUR NEAR LUDHIANA

Fig 10 & 11 – SUTLEJ RIVER BEFORE ENTERING LUDHIANA CITY

Besides above, a survey will be conducted for knowing the present scenario for disposal of domestic wastewater from the common people. It will also benefit in creating awareness of the concept of domestic wastewater and its disposal. It will be done with the help of questionnaires. Few selected questions will be prepared in a particular questionnaire. Those questionnaires will be randomly distributed to the common people near of Sutlej. Attempts will be taken to cover up the maximum possible wards of Sutlej from every zone. Feedback from the survey will be recorded. The mode of questionnaires will be offline as well as online. In offline mode, door to door survey will be conducted and in online mode, questionnaires will be send via mail to the local people. The questions that will be used in questionnaires are given below:

How can you contribute for the reduction of waste water?

Are you aware of the wastewater treatment and sewage treatment plants?

What according to you is the best way for disposal of domestic wastewater?

What kind of sanitation facility your house and locality have?

What kind of domestic sewage treatment plant will you prefer for you locality?

Are you willing to use the treated wastewater (which is fulfilling the standards) for domestic purpose?

Are you willing to help and contribute in the construction of sewage treatment plant?

Do you think that the construction of STP would be a solution to the frequent floods that the state is facing?

Chapter -4

RESULTS

REPORT 2012 to 2016

Report 2012

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	7.1	23/20	6.8	8.8	2.0	2300
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.9	23/21	4.2	94	27	70000

6.1 Table 1

Report 2013

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	7.8	26/21	6.8	6.0	1.2	900
2	100m D/s of Buddha Nallah Sutlej Confluence point	6.7	28/22	2.0	32	6.0	22000

6.2 Table 2

Report 2014

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	7.1	28/26	7.2	8.6	2.0	1100
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.5	29/25	1.6	56	8.0	40000

6.3 Table 3

Report 2015

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	7.7	32/22	6.3	4.0	0.0	280
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.6	31/21	4.4	68	24	35000

6.4 Table 4

Report 2016

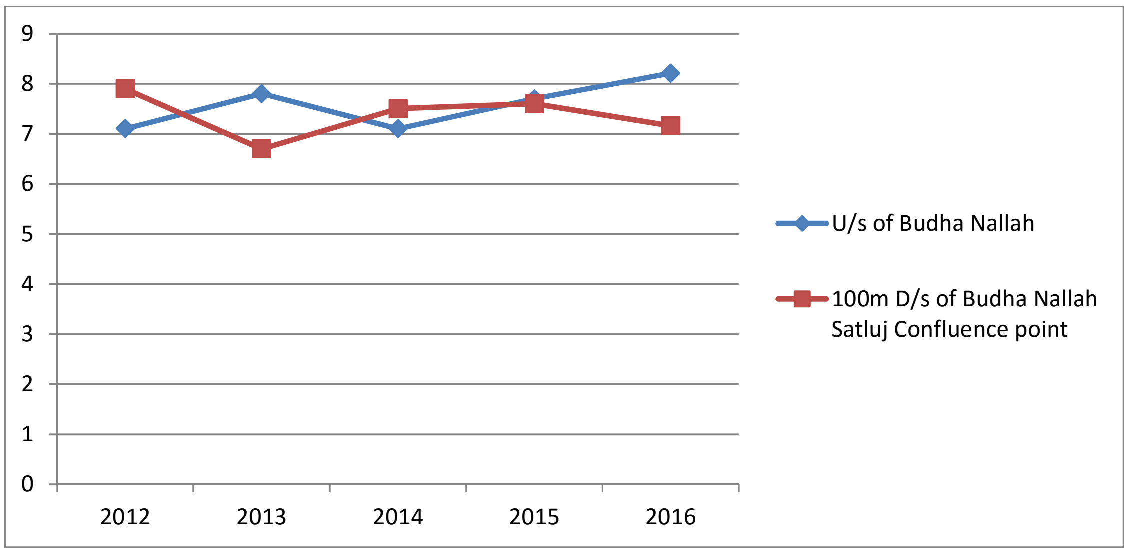
S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	8.21	36/19	7.4	6.4	1.2	200
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.16	36/19	5.8	32	7	21000

6.5 Table 5

Table for Various Parameters

1. pH

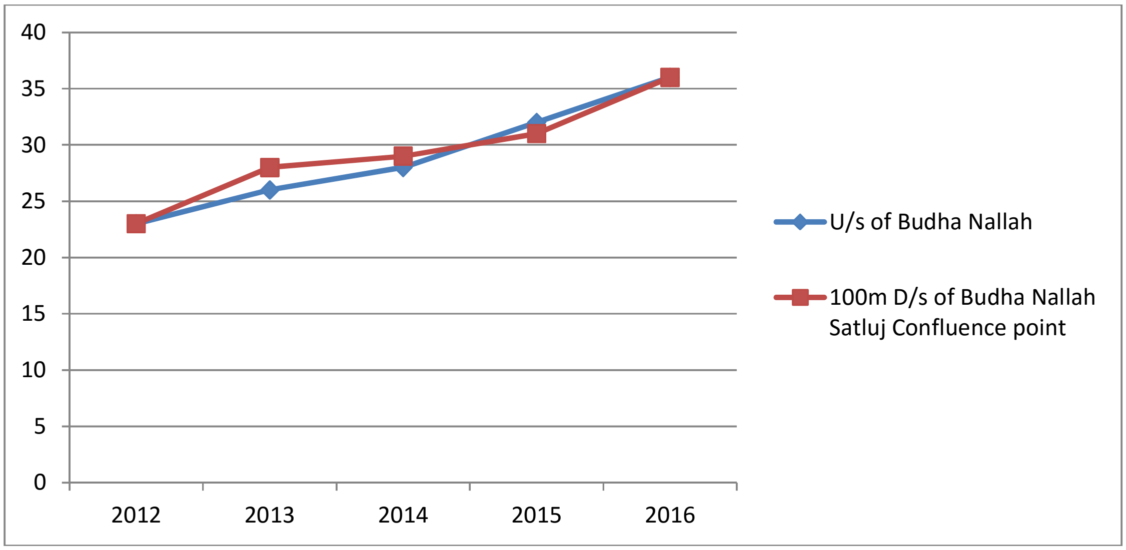
Sr. No.	Name of Station	2012	2013	2014	2015	2016
1	U/s of Budha Nallah	7.1	7.8	7.1	7.7	8.21
2	100m D/s of Budha Nallah Sutlej Confluence point	7.9	6.7	7.5	7.6	7.16



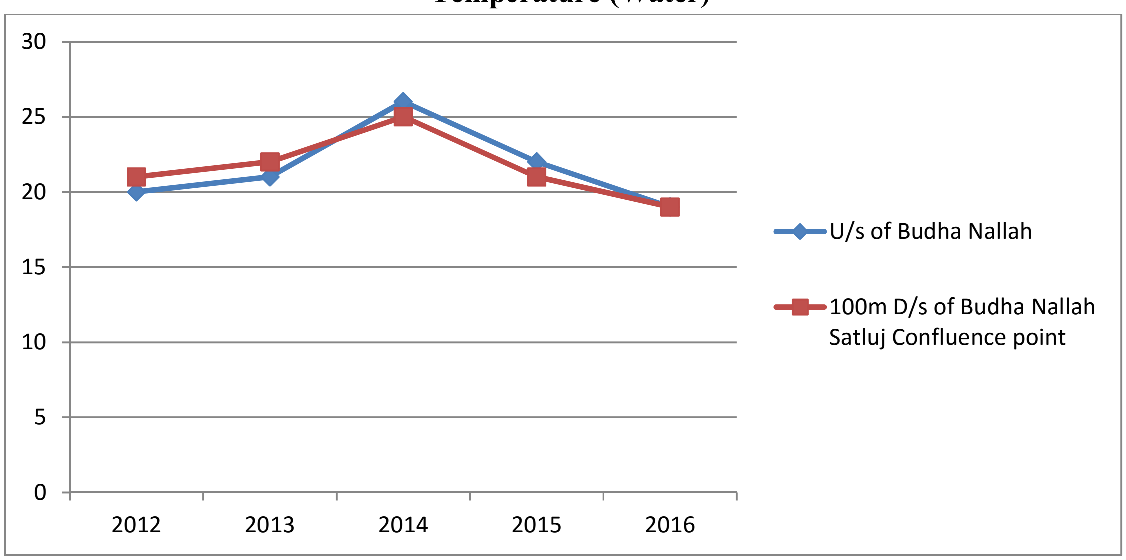
2. Temperature (Air/Water)

Sr. No.	Name of Station	2012	2013	2014	2015	2016
1	U/s of Budha Nallah	23/20	26/21	28/26	32/22	36/19
2	100m D/s of Budha Nallah Sutlej Confluence point	23/21	28/22	29/25	31/21	36/19

Temperature (Air)

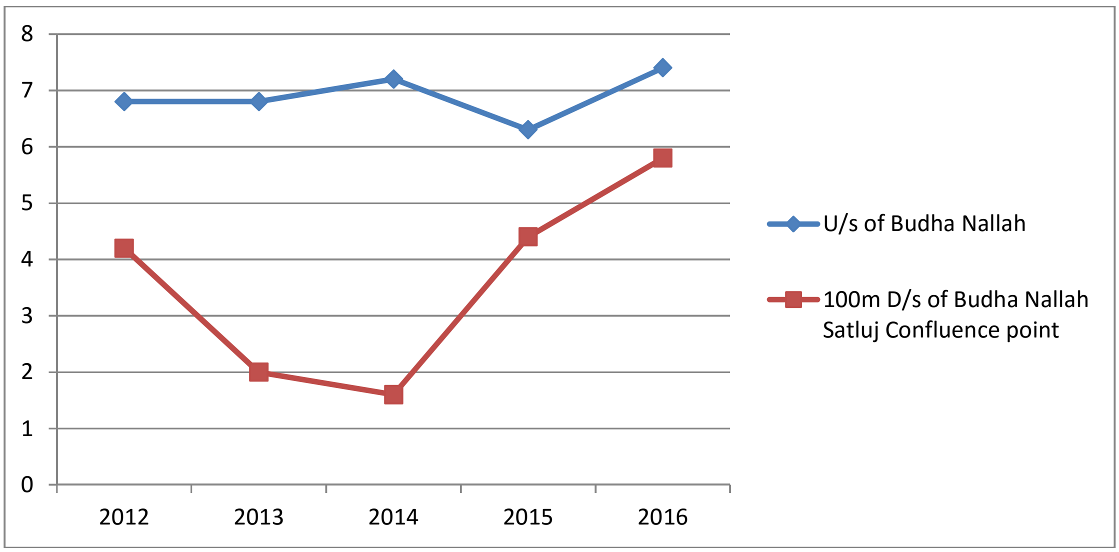


Temperature (Water)



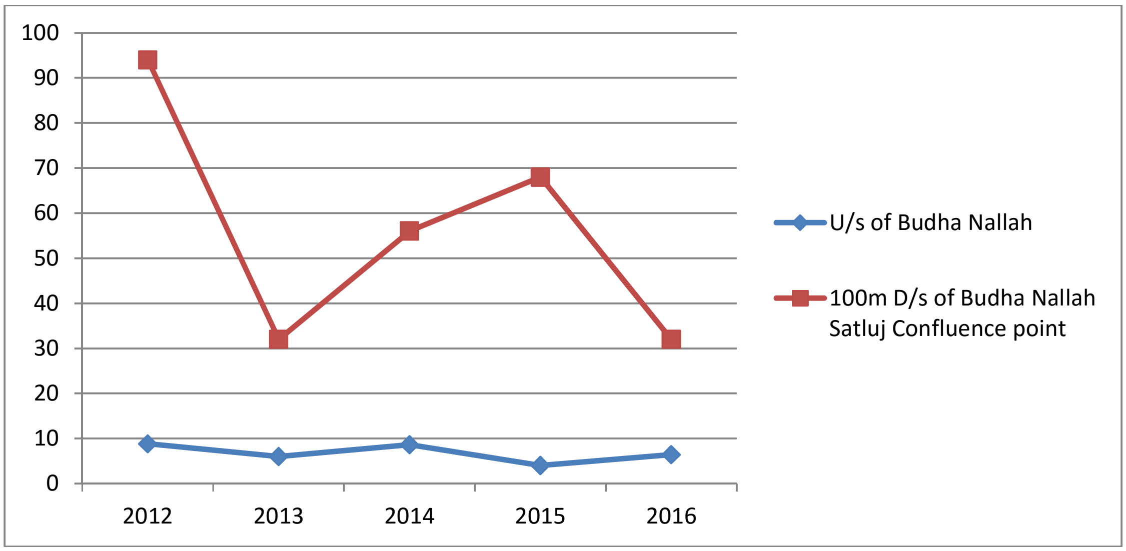
3. DO mg/l

Sr. No.	Name of Station	2012	2013	2014	2015	2016
1	U/s of Budha Nallah	6.8	6.8	7.2	6.3	7.4
2	100m D/s of Budha Nallah Sutlej Confluence point	4.2	2	1.6	4.4	5.8



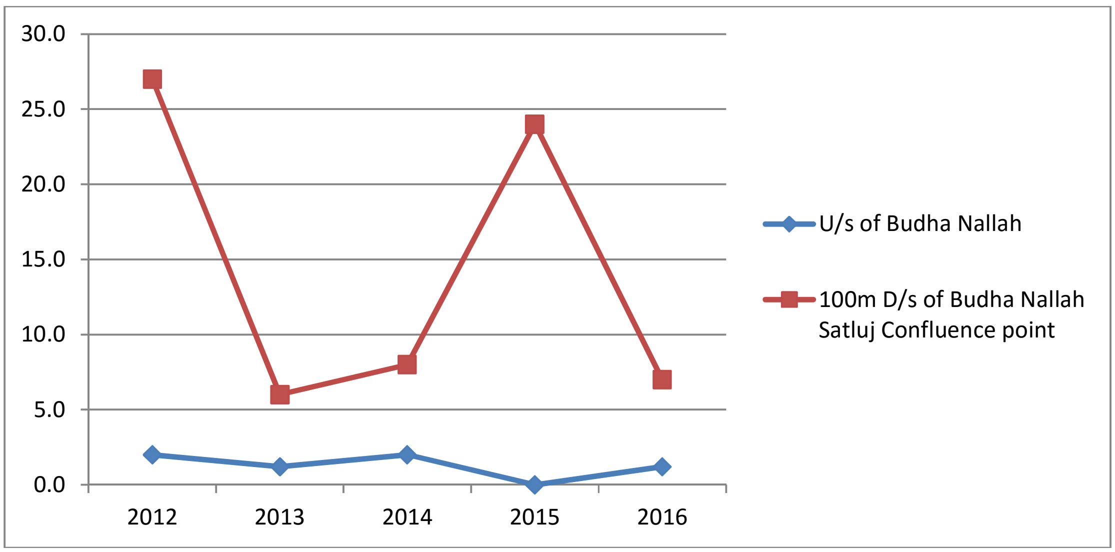
4. COD mg/l

Sr. No.	Name of Station	2012	2013	2014	2015	2016
1	U/s of Budha Nallah	8.8	6	8.6	4	6.4
2	100m D/s of Budha Nallah Sutlej Confluence point	94	32	56	68	32



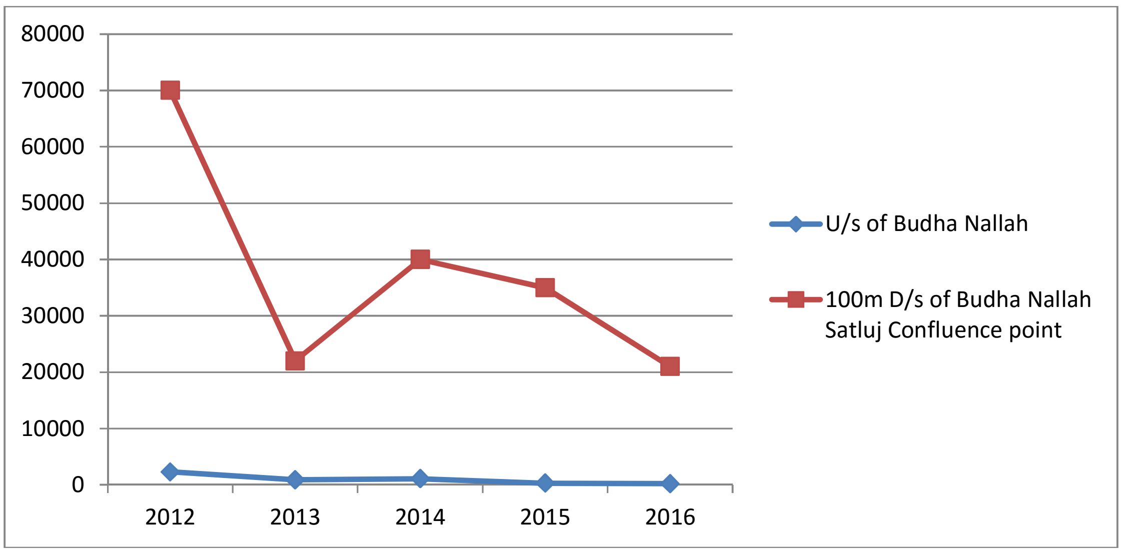
5. BOD mg/l

Sr. No.	Name of Station	2012	2013	2014	2015	2016
1	U/s of Budha Nallah	2.0	1.2	2.0	0.0	1.2
2	100m D/s of Budha Nallah Sutlej Confluence point	27	6.0	8.0	24	7



6. F.coli MPN/100ml

Sr. No.	Name of Station	2012	2013	2014	2015	2016
1	U/s of Budha Nallah	2300	900	1100	280	200
2	100m D/s of Budha Nallah Sutlej Confluence point	70000	22000	40000	35000	21000



Report Nov, 2016

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	7.9	23/17	6.4	8	1.2	150
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.3	25/18	5.2	44	14	30000

Report Dec, 2016

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	8.3	20/15	7.6	11.2	1.3	180
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.8	21/15	4.8	24	3.8	21000

Report Jan, 2017

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	7.61	19/17	7.5	10	2.0	400
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.52	19/16	5.1	108	40.0	17000

Report Feb, 2017

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	7.48	20/18	6.8	16	2.0	1400
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.28	20/19	3.2	272	103.0	31000

Report March, 2017

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	7.5	35/24	7.0	12	2.0	1700
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.46	35/26	3.0	280	108.0	31000

Report April, 2017

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	7.33	38/24	7.0	16	2.0	940
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.17	38/30	2.6	384	105.0	46000

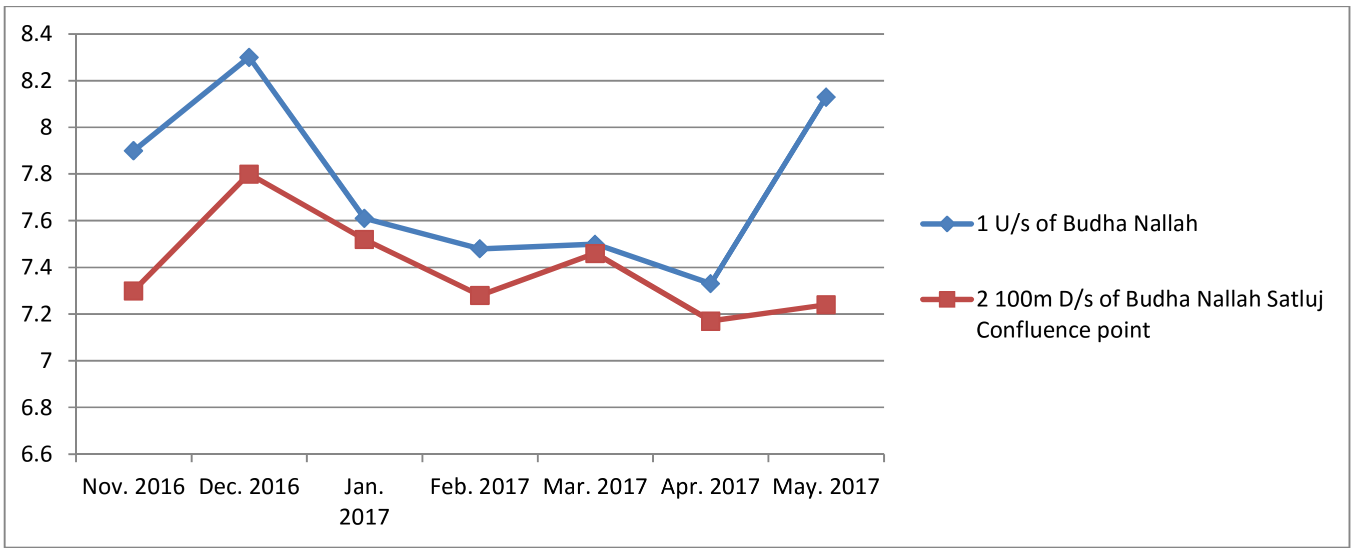
Report May, 2017

S.N.	Name of Station	pH	Temperature (Air/water)	DO mg/l	COD mg/l	BOD mg/l	F.coli MPN/100ml
1	U/s of Buddha Nallah	8.13	37/28	6.4	8	BDL	200
2	100m D/s of Buddha Nallah Sutlej Confluence point	7.24	38/29	2.6	44	15.0	14000

Table for Various Parameters

1. pH

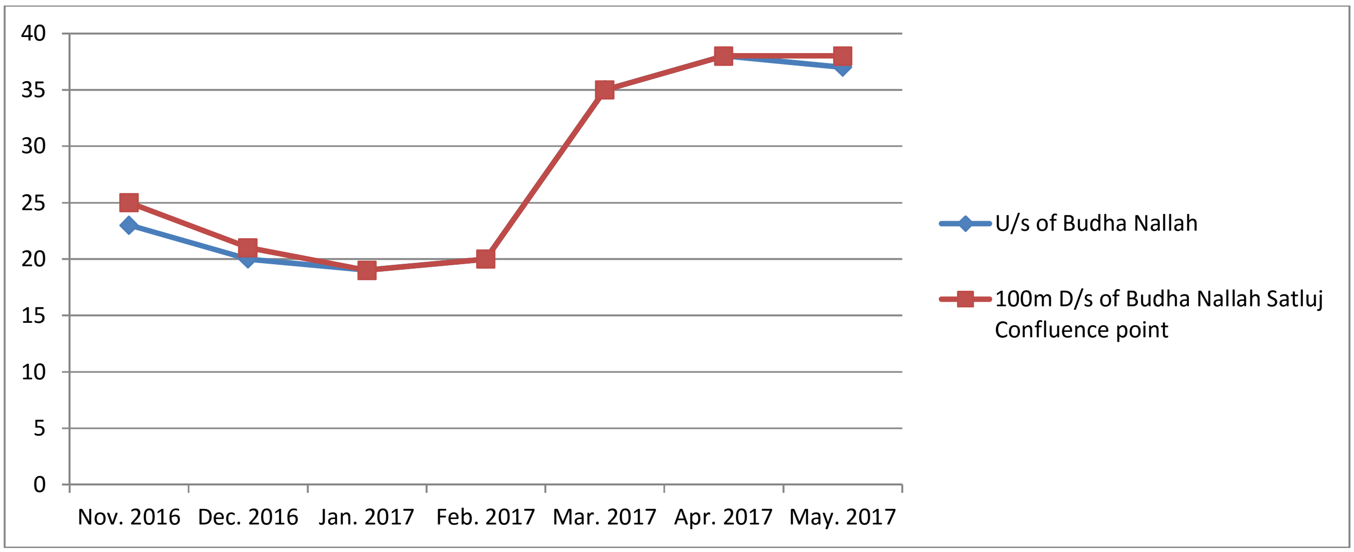
Sr. No.	Name of Station	Nov. 2016	Dec. 2016	Jan. 2017	Feb. 2017	Mar. 2017	Apr. 2017	May. 2017
1	U/s of Budha Nallah	7.9	8.3	7.61	7.48	7.5	7.33	8.13
2	100m D/s of Budha Nallah Sutlej Confluence point	7.3	7.8	7.52	7.28	7.46	7.17	7.24



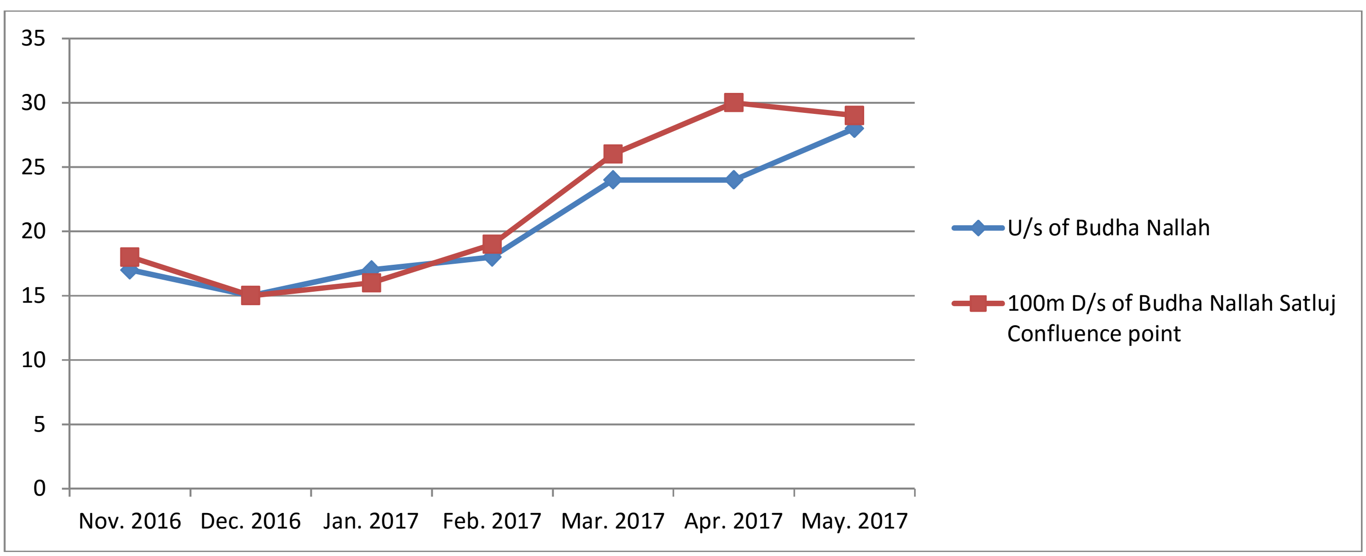
2. Temperature (Air/Water)

Sr. No.	Name of Station	Nov. 2016	Dec. 2016	Jan. 2017	Feb. 2017	Mar. 2017	Apr. 2017	May. 2017
1	U/s of Budha Nallah	23/17	20/15	19/17	20/18	35/24	38/24	37/28
2	100m D/s of Budha Nallah Sutlej Confluence point	25/18	21/15	19/16	20/19	35/26	38/30	38/29

Temperature (Air)

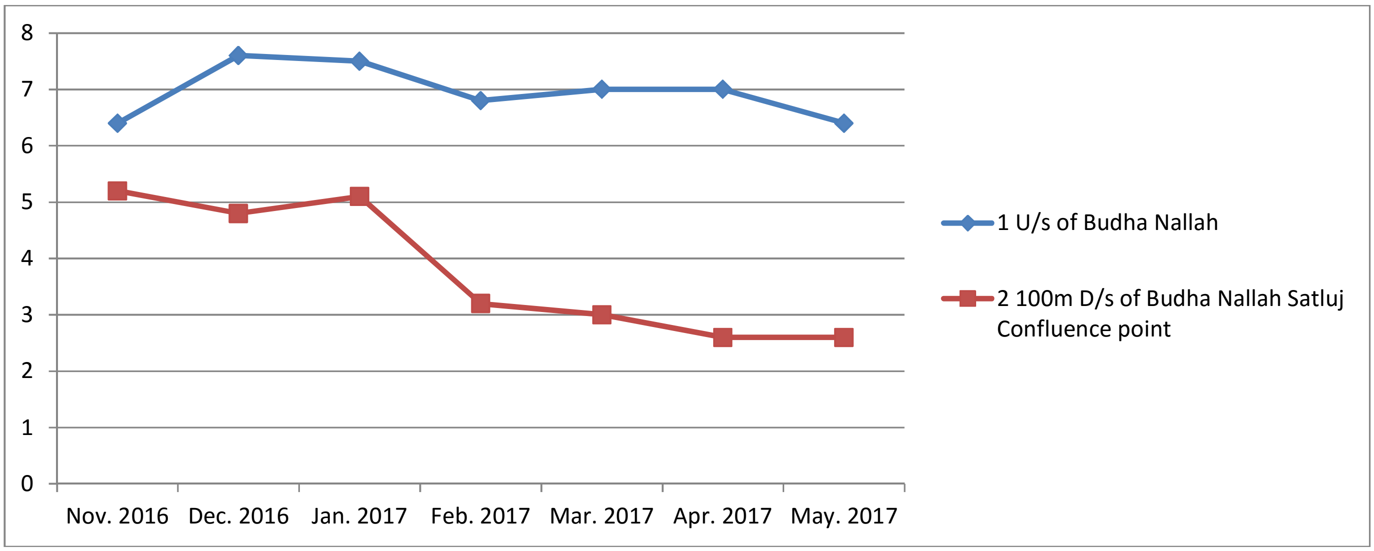


Temperature (Water)



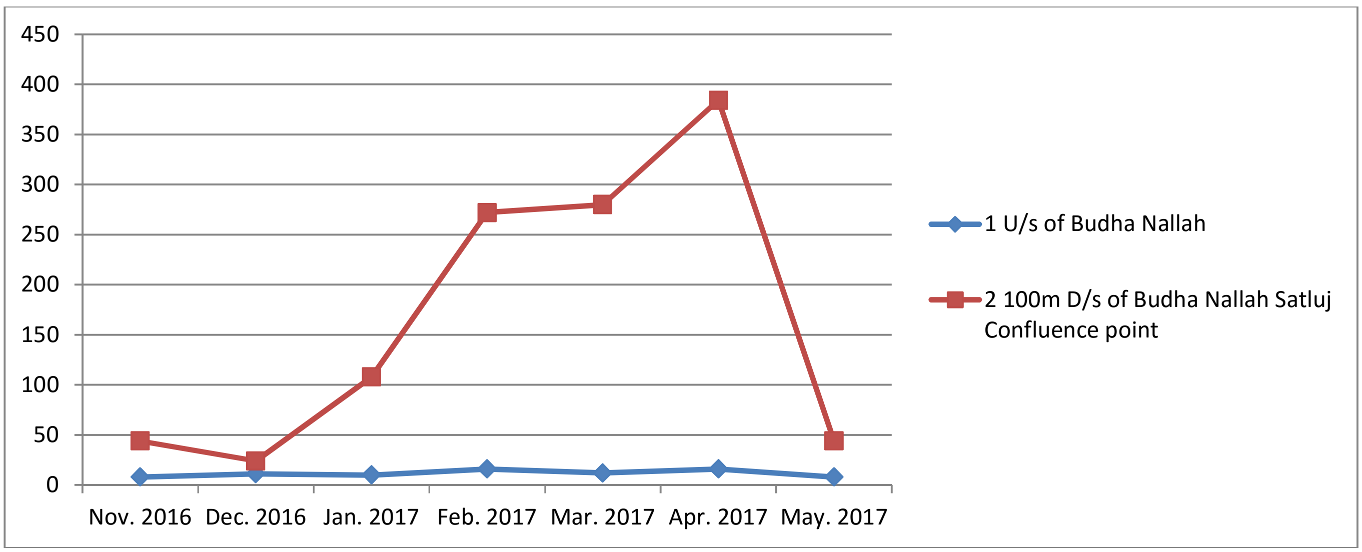
3. DO mg/l

Sr. No.	Name of Station	Nov. 2016	Dec. 2016	Jan. 2017	Feb. 2017	Mar. 2017	Apr. 2017	May. 2017
1	U/s of Budha Nallah	6.4	7.6	7.5	6.8	7.0	7.0	6.4
2	100m D/s of Budha Nallah Sutlej Confluence point	5.2	4.8	5.1	3.2	3.0	2.6	2.6



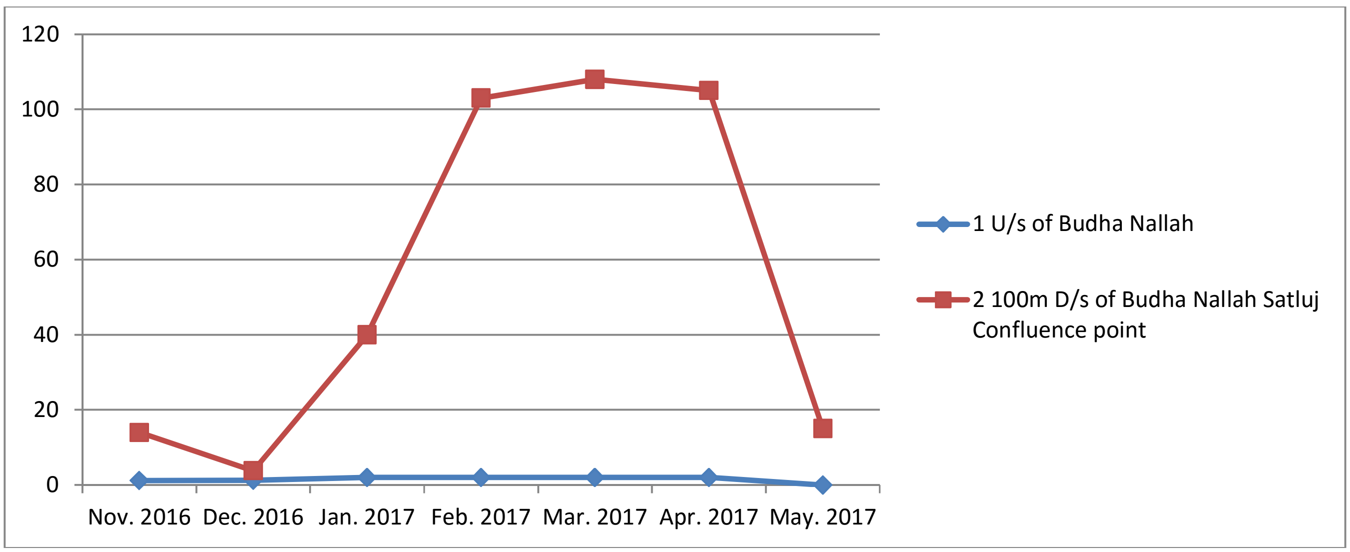
4. COD mg/l

Sr. No.	Name of Station	Nov. 2016	Dec. 2016	Jan. 2017	Feb. 2017	Mar. 2017	Apr. 2017	May. 2017
1	U/s of Budha Nallah	8	11.2	10	16	12	16	8
2	100m D/s of Budha Nallah Sutlej Confluence point	44	24	108	272	280	384	44



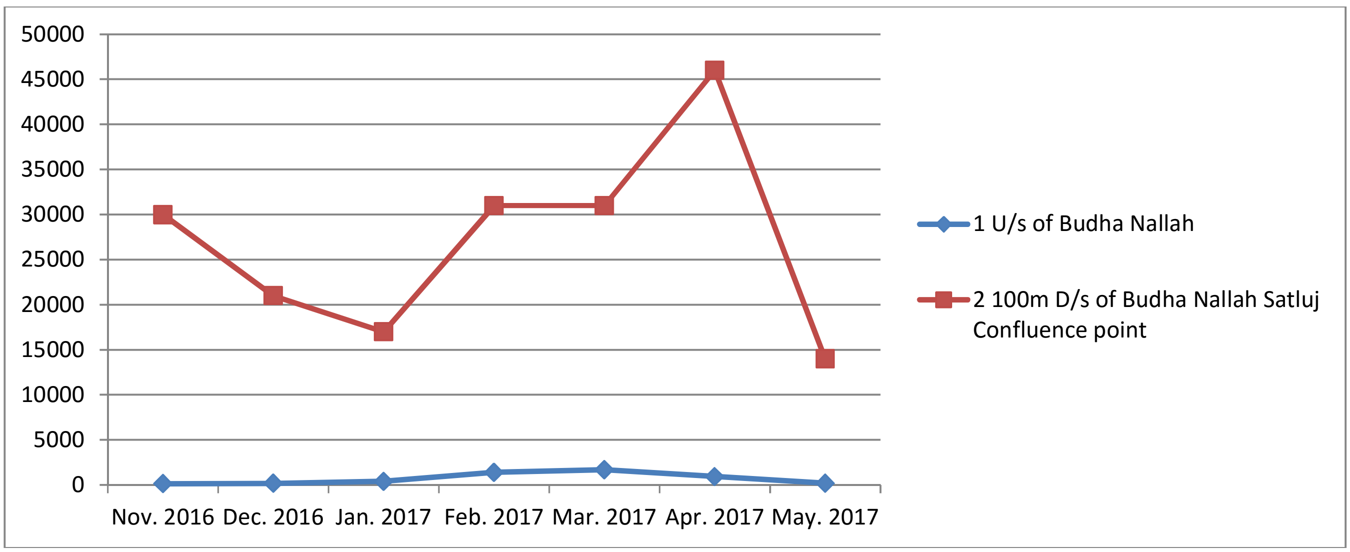
5. BOD mg/l

Sr. No.	Name of Station	Nov. 2016	Dec. 2016	Jan. 2017	Feb. 2017	Mar. 2017	Apr. 2017	May. 2017
1	U/s of Budha Nallah	1.2	1.3	2.0	2.0	2.0	2.0	0.0
2	100m D/s of Budha Nallah Sutlej Confluence point	14	3.8	40.0	103.0	108.0	105.0	15.0



6. F.coli MPN/100ml

Sr. No.	Name of Station	Nov. 2016	Dec. 2016	Jan. 2017	Feb. 2017	Mar. 2017	Apr. 2017	May. 2017
1	U/s of Budha Nallah	150	180	400	1400	1700	940	200
2	100m D/s of Budha Nallah Sutlej Confluence point	30000	21000	17000	31000	31000	46000	14000



CHAPTER 5

CONCLUSION

Sutlej river water

Control on wastewater flow from various industries going into Buddha Nallah which is ultimately flowing into river Sutlej. The domestic discharge flowing directly into the nallah should also be attached into the sewerage network and shall be passed through Sewage treatment Plant and then treated outlet be discharged into the river to prevent its further deterioration. Or the second option is that after treatment, water should be used onto land for irrigation and agricultural purposes instead of flowing into the river. This will ensure control of pollution and lasting of fresh pure water for future generation. This will also save approx. 60 tubewells as discharge from Buddha Nallah is approximately 200 MLD. This will further help in saving groundwater as its extraction will be reduced.

Result

The above measures taken will ensure that we will never face the waste water treatment and river pollution issues and obtained a healthy environment with respect to availability of water. We will never face shortage of water and obtained a better river Sutlej.

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