iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** V **Month of publication:** May 2024

DOI: https://doi.org/10.22214/ijraset.2024.62575

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

Assessment of Surface Water Quality Drain Using Various Physicochemical Parameters of Lasara Dhanola Drain, Punjab

Sukhveer Singh[1], Manpreet Kaur Verma[2]
Department of Chemistry, Desh Bhagat University, Mandi Gobindgarh-147301, Punjab, India

Abstract: In this study, observations were carried out in the surface waters of Lasara Dhanola drain of Punjab within to determine water quality. The basic physicochemical variables were used to determine water quality. Taking into account the World Health Organization's drinking water standards and the water quality index (WQI) were used in determining the water quality. In addition, irrigation water quality was examined. Some of the water quality parameters exceed the recommended limit values in all at all sites. According to these values, the Lasara Dhanola drain water belongs to the 'very poor' class in terms of irrigation water quality. According to results of factor analysis, pH, temperature, electrical conductivity, suspended solid matter, biological oxygen demand, total hardness, total alkalinity, calcium, nitrate, chlorides, fluorides and dissolved oxygen are the main variables responsible for the processes in the ecosystem.
Keywords: Irrigation water quality, Lasara dhanola drian, Surface water, Water quality, Water quality index.

I. METHODOLOGY

In order to assess the water quality of Lasara-Dhanola drain in Malwa region of Punjab State. The area comprises of several districts of Malwa region including Ludhiana, Malerkotla, Sangrur, Barnala and Bathinda to find out whether the water sources is suitable for health and irrigation. The location of the field work started from Jargari a village in Ludhiana district and end point of Lasar–Dhanola drain was village Pathrala in Bathinda district. Moreover, water quality of ground water in Malwa region was also evaluated. The description of various studies conducted on drain water and ground water is as under.

The field study was conducted to examine the water quality of Lasara-Dhanola drain comparative assessment of surface water of the drain. The scope of sampling was to handle the water sample very carefully to breakout any content changes before the tests are made. Sampling was carried out during the in session 2022-2023. Total 15 samples of water were collected from different sites of drain for determination of physicochemical quality.

Sample No.	Source	Area/Village	District
D_1	Drain Water	Jargari	Ludhiana
D_2	Drain Water	Dudhal	Ludhiana
D_3	Drain Water	Ranwan	Malerkotla
D_4	Drain Water	Malerkotla	Malerkotla
D_5	Drain Water	Naudharani	Malerkotla
D_6	Drain Water	Wazirpur	Sangrur
D_7	Drain Water	Amla Singh Wala	Barnala
D_8	Drain Water	Barnala	Barnala
D_9	Drain Water	Khudi Kalan	Barnala
D_{10}	Drain Water	Ghunas	Barnala
D_{11}	Drain Water	Jethuke	Bathinda
D_{12}	Drain Water	Mandi kalan	Bathinda
D_{13}	Drain Water	Mansa Khurd	Mansa
D_{14}	Drain Water	Jiwan Singh Wala	Bathinda
D_{15}	Drain Water	Pathrala	Bathinda

Drain water samples were collected in clean polyethylene bottles of 2 liter capacity. Care was taken to keep the bottle to avoid the unwanted materials enters in the bottle while sampling. The drain water samples were collected from all the sites from morning to evening time. The bottles were rinsed with acid water, followed by washing with double distilled water. The bottles were properly sealed and labeled exhibit sample number, location, sampling time and date. All information was noted in the field book to avoid any confusion and error. The physical quality parameter such as temperature was notable at the site of sample collection. After collection, all samples sent to laboratories for detailed physicochemical analysis.

The samples of various locations were examined for determination of degree of pollution with respect to the following physicochemical parameters.

- Ph
- EC (Electrical Conductivity)
- T.D.S (Total Dissolved Solids)
- T.H (Total Hardness)
- Calcium
- Magnesium
- T.A (Total Alkalinity)
- Turbidity
- Chlorides
- Fluoride
- . Residual Chlorine
- Nitrate

Standard method for analysis

Samples were collected from various selected spots were analyzed for physicochemical parameters in order to find out the water quality of Lasar-Dhanola drain. Standard methods given in 'Standard Methods for the Examination of Water and Wastewater' 22nd Edition, 2012 by American Public Health Association and 'Indian Standards Method of Sampling and Test (Physical and Chemical) for water and wastewater' by Bureau of Indian Standards (1984) were used for determination of various physicochemical parameters.

1) *Measurement of pH*

pH was measured using a pH meter by electrometric method as standard IS – 3025 (P-11-2022) was used. The pH electrode was initially rinsed with distilled water and then calibrated by placing the pH electrode into buffer solutions. The instrument was adjusted to read the pH value of the buffer solution. This procedure was used to standardize the reading of instrument before doing the sample testing. The pH value was determined by measurement of the electromotive force of a cell consisting of an indicator electrode (such as a glass electrode) immersed in the test solution and a reference electrode (usually mercury 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) *Electrical Conductivity*

The conductivity of the samples were determined by laboratory method 2510B (Page no-2/59- 61) was used. Electrical conductivity of was measured with the help of a conductivity meter. The instrument was initially standardized by rinsing with the standard reference solution (0.01 M KCl) which at 25ºC has a conductivity of 1412 µS cm^{-1}. The adjusting knob on the conductivity meter was adjusted to make sure the read out matched this value. The electrode of conductivity meter was rinsed with 3 portions of 0.01 KCl solution for calibration. After calibration, 3 parts of each sample was used to rinse the electrode and then dipped in the sample for the actual measurement. Values of conductivity were in Siemens per centimeter.

3) *Total Dissolved Solids*

The Gravimetric method as per standard IS-3025 (P-16-2023) was used to determine the total dissolved solids or filterable residue. Samples were stored in refrigerator at 4ºC to minimize the microbiological decomposition of solids. The samples were filtered through glass fibre filter in the evaporated dish. Evaporation was done in drying oven at 98ºC.

After complete evaporation of water, residue was dried to constant mass at 103ºC-105ºC and weighed the dish. Calculation: Calculate the total dissolved solids (filterable residue) from the following equation: Filterable residue, mg/l = 1000M/V Where M = Mass in mg of filterable residue, and V = Volume in ml of the sample.

4) Total Hardness

EDTA (Ethylene diamine tetraacetic acid) method for determination of total hardness was used given in method IS-3025(P-21) (RA-2019) using a standard calcium solution for standardization. Solution of hydroxylamine hydrochloride with addition of buffer solution and indicator Erichrome Black T was done in sample. Solution was titrated with standard EDTA solution and stirred continuously to disappear the red colour of the solution. At end point, blue colour was appeared and procedure was followed to find out the hardness. Calculate the hardness as follow: Total Hardness = $[1000(V_1-V_2)/V_3] \times CF (CaCO_3)$, mg/l Where V_1= volume in ml of the EDTA standard solution used in the titration for the sample. V_2= volume in ml of the EDTA solution used in the titration for blank. V_3= volume in ml of the sample taken for the test. CF= X_1/X_2 =correction factor for standardization of EDTA. X_1= volume in ml of standard calcium solution taken for standardization, and X_2= volume of ml of EDTA solution used in the titration.

5) Calcium

Calcium was determined by using EDTA titration method as per standard IS-3025(P-40). EDTA solution was standardized by standard zinc solution. Water samples were pre-treated with concentrated nitric acid and used for determination of calcium. Due to high pH, Solution was titrated immediately by EDTA solution with addition of sodium hydroxide solution and indicator murexide. Solution was continuously stirred with slowly addition of EDTA solution. Solution changed from pink to purple at the end point and noted the final reading of the solution. Calculations: Calcium (Ca), mg/l= $A \times B/V \times 1000$ Where A= volume in ml of EDTA solution used for titration. B= mass in mg of calcium equivalent to 1ml of EDTA solution, and V= volume in ml of the sample taken for the test.

6) Magnesium

Volumetric method using EDTA was used to determine the magnesium. Standard method IS3025(P-46) was adopted. Water samples were titrated against with standard EDTA solution using Erichrome Black T indicator. Addition of hydroxylamine solution, potassium cyanide and triethanolamine solution were used. Indicator was used after the addition of buffer solution in dilute solution. Solution was titrated with 0.01M EDTA solution and slowly stirred at end point. Colour was changed from red to blue and reading was noted in the notebook. Calculations: Magnesium (as Mg), mg/l percent by mass = $0.024 \times 1000 \times (V_2-V_1)/ V$ Where V= volume in ml of the sample taken for the test. V_1= volume in ml of EDTA consumed in titration for calcium determination in the same aliquot of the solution of sample. V_2= volume in ml of EDTA solution consumed in the titration.

7) Total Alkalinity

The standard method IS-3025(P-23) was followed for the analysis of alkalinity. The potentiometer was used for the determination of alkalinity. Samples were titrated with standard solution of sulphuric acid to pH 8.3 to pH 3.7 using a potentiometer. Calculations: Alkalinity in the sample as follows: Total alkalinity (as mg/l of $CaCO_3$) = $(A+B) \times N \times 50{,}000/V$ Where A = ml of standard sulphuric acid used to titrate to pH 8.3, B = ml of standard sulphuric acid used to titrate from pH 8.3 to pH 3.7, N = normality of acid used, and V = volume in ml of sample taken for test.

8) Turbidity

Turbidity was analyzed as per standard method given in IS 3025 (P-10). Turbid meter was used to determine the turbidity of water sample. Stock standard suspensions of hydrazine sulphate and hexamethylene tetramine solution were used for calibration. Standard calibration procedure was performed for accurate reading. The values of water samples were expressed in Nepheolmetric Turbidity Units in the range of 0-40. Higher values were obtained by dilution of the sample. Calculations: Turbidity of diluted samples by using the following equation: Turbidity units = $A \times (B+C)/C$ Where: A= turbidity units found in diluted sample. B=volume in ml of dilution water used C= volume of sample in ml taken for dilution.

9) Chlorides

The standard method IS-3025(P-32) was followed for determination of chlorides. Potentiometric method with silver nitrate solutions with a glass and silver-silver chloride electrode system were used.

For standardization, sodium chloride solution using concentrated nitric acid was titrated with standard silver nitrate titrant. The end point of the titration was occurred due to greatest change in voltage by small and constant increment of silver nitrate. Calculation: Chloride (as Cl), mg/l = $(V_1-V_2) \times N \times 35450/ V$ Where, V_1= Volume in ml of silver nitrate titrant used in sample V_2= Volume in ml of silver nitrate used in blank N= Normality of titrant V= Volume in ml of the sample used

10) Fluoride

A fluoride of sample was determined by Zirconium alizarin method. Procedure was followed as per standard IS 3025 (P-60).The minimum detection limit of fluoride was 0.05mg/l. Water sample was taken with addition of standard sodium fluoride solution and zirconium alizarin reagent. The sample and standards were at the same temperature (1^oC to 2^oC). Mixed and compared colors after 1 hour standing. The volume of standard sodium fluoride solution contained in the tube was noted in which the match of the sample under test was obtained. Calculation: Fluoride (as F), mg/l= 1000W/V Where W = weight of fluorides (as F) in the standard solution matched by the sample. V = volume of the sample taken for the test in ml.

11) Residual Chlorine

Iodometric method was used for determination of residual chlorine as per standard method given in IS 302 (P-26). Acetic acid was used in water sample to decrease the PH of solution. Potassium iodide crystals were also added in solution. Titrated the solution against sodium thiosulphate until yellow colour of librated iodine was almost discharged. Starch was also needed in solution before titration to find out the lowest residual chlorine in the water. Calculations: Residual chlorine, mg/l = $V_1 \times N \times 35450/V_2$ Where, V_1 = Volume of standard sodium thiosulphate used V_2 = volume of sample taken for test, and N = normality of sodium thiosulphate used.

12) Nitrate

Ion chromatography technique as per standard method APHA 4110 was followed to determine the nitrate in water sample. Method detection limit of sample was 0.5 mg/l. Ion chromatograph including syrings, analytical columns, gases, detector and data system was followed. During analysis, the sample merged with the eluent stream and was pumped through the ion chromatographic system. A water sample was injected into a stream of carbonatebicarbonate eluent and passed through a series of ion exchangers for separation. The separated anions and their acids were measured by conductivity. They were identified on the basis of retention time as compared to standards. Peak height and retention time was recorded on strip chart recorder. Concentration of nitrate anion was expressed in mg/l.

13) Determination of physicochemical parameters

Water samples were carried out by Punjab Water Supply and Sanitation Department, Mohali and analyzed in their Regional Advance Water Testing Laboratory using state of art instrumentation including ICPMS (Inductively Coupled Plasma Mass Spectrometry). Instrument model was Agilent Technolgies 7700. Nitric acid (5% acidified) was acted as reagent. Milli Q water used for preparation of blank solutions and standard stock solutions. Prepared the standard solutions at known concentrations (in ppb) for calibrations. Followed the manufacture's standard operating procedure for initialization, mass calibration, gas flow optimization and other instrument operating conditions. Data collected in excel form and values were expressed in ppm (parts per million).

List of methods used to calculate various physiochemical parameters of water.

S. No.	Parameter	Reference Method
1.	pH	IS 3025 (Part 11-2022) Electrometric Method
2.	Colour	IS 3025(Part 4-2021) visual Comparison Method
3.	Odour	IS 3025 (Part 5-2018) (Second revision)
4.	Taste	IS 3025 (Part 8-2023)
5.	TDS	IS 3025 (Part 16-2023) Gravimetric Method
6.	Turbidity	IS 3025 (Part 10-2023) Nephelometric Method
7.	Alkalinity	IS 3025 (Part 23-2023) Indicator Method
8.	Hardness	IS 3025 (Part 21-2009) (RA 2019) EDTA Method
9.	Calcium	IS 3025 (Part 40-1991) EDTA Titrimetric Method
10.	Magnesium	APHA (24th Ed.2023) method:3500-Mg+2 B by Calculation Method
11.	Iron	Spectrophotometric Titrations

12.	Fluoride	APHA 4500 F-(23rd Ed. 2017)/IS-3025 (Part-60)
13.	Nitrate	Spectrophotometric Method/ APHA 4500 NO3-(23rd Ed. 2017)
14.	Total Coliform	IS-1622 MPN Method
15.	E-Coli	IS-1622 MPN Method
16.	BOD	APHA 5210 (23rd Ed. 2017)
17.	COD	APHA 5220 (23rd Ed. 2017)

Following is the list of laboratories that we have approached for testing various physiochemical parameters water.
- District water testing laboratory Malerkotla
- Regional water testing lab Sangrur
- Industrial testing laboratory 2 consulting house
- Department of water supply and sanitation

II. RESULS AND DISCUSSIONS

A. Surface Water Quality Analysis For Irrigation Purpose

Water samples were collected from 15 different locations of Lasara-Dhanola drain in the Malwa region of Punjab (comprising different villages/districts of Malwa Region) as given in Table 1. Water samples assayed by physico-chemical parameters including pH, EC, T.D.S, T.H, Calcium, Magnesium, Total Alkalinity , Turbidity , Chlorides , Fluoride , Residual Chlorine and Nitrate shown in Table 2. The results of this study revealed that some variations in the physical and chemical parameters have been observed. The water quality of Lasara-Dhanola drain was analyzed and obtained values were compared with Bureau of Indian Standards, 2012 (BIS) and World Health Organisation (WHO) to classify the water polluted locations.[1] The analysis data reports that pH, turbidity and iron were found to be higher than the permissible limit prescribed by WHO and BIS standards. The investigation reveals that the waterquality of Lasra-Dhanola drain at most of sampling stations is found to be unsafe and cannot be used for the irrigation and domestic purposes. Results of different parameters are discussed below:

1) pH

pH is a term that broadly describes the intensity of an acid or alkali state of a solution. Most of samples are slightly alkaline in nature. The pH range of surface water lies between 6.5 to 8.5.[2] Allwater samples were found within permissible limit prescribed by BIS and WHO standards. The sampling site D-9 has highest pH whereas D-7 has lowest pH. It has been reported that pH of the water was almost uniform magnitude in all the study samples and it varied between 7.33 to 7.5 which was tolerant of life system. Fluctuations in the optimal pH range may be increase ordecrease in toxicity of poisons in water sources.

2) Electrical Conductivity

Electrical conductivity is a measure of the ability of water to conduct electrical current. Conductivity values ranged from at different sampling sites of Lasara-dhanola drain. The minimum and maximum values 1660 and 2000 µs/cm are obtained at sampling sites D2 and D9 respectively. This indicated that drain water of different sites has different quality. The results indicates that the all water samples has the value of electrical conductivity beyond the beyond the desirable limits. so this is not safe for drinking and irrigation purposes.

3) Total Dissolved Solids

The term TDS describes all dissolved solids (usually mineral salts) in water. The acceptable limitof TDS is 500 mg/l (BIS, 2012) TDS of the water sample in the present study varied from 830 mg/L to 1004 mg/L, which is beyond the optimal TDS limits.[3] The highest TDS concentration was recorded at sample site D-9. There may be variations in the dissolved solids in water could affect the measurement of conductivity but gives no indication of the corresponding quantity of different components. There is a relationship between conductivity and total dissolved solids in water.

4) Total Hardness

Hardness mainly depends upon the amount of calcium or magnesium salts or both. It is the property of water which prevents the formation of leather with soap and increases the boiling points of water. Durfor and Becker have classified water as soft, moderate, hard and very hard asgiven in the Table below:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

Classification of the water on the basis of Total Hardness (T.H.)

Description	Total Hardness (mg/L)
Soft	0-60
Moderately hard	60-120
Hard	120-180
Very hard	>180

Hardness of water is one of most important characteristics of surface water to utilization in differentpurposes. BIS desirable limit for total hardness is 200 mg/L. In present study, the hardness of analysed samples fluctuated from 310-400 mg/L as $CaCO_3$. The highest value of total hardness was observed at sample D-1.

5) Turbidity

Turbidity refers to the cloudiness or haziness of a fluid caused by suspended solids or fine particles that are invisible to the naked eye. In the context of water, turbidity is a measure of the relative clarity of the water and is an important parameter in assessing water quality. High turbidity levels can be indicative of sediment runoff, algae growth, or other pollutants in the water. The turbidity values varied between 1.29 to 11.51 NTU and found above the permissible limits prescribed by BIS (10500-2012).[4] Most of the sampling sites showed low turbidity values and in between the permissible limits. The low turbidity means that the liquid is clearer. Turbidity is caused by solid particles being suspended in a liquid.

6) Calcium

Calcium is a common mineral found naturally in water sources, and its presence can have various implications depending on the concentration and context. While calcium is a naturally occurring mineral in water and essential for human health, its presence can affect water hardness and water treatment processes. Monitoring calcium levels in water is important for both health and practical reasons related to water quality and treatment. In present study, the result showed the calcium between 40 to 90 mg/L. All sampling sites were within the BIS acceptable limits (75mg/L).[5] It has been studied that the human body needs calcium approximately 0.7 to 2.0 gramsper day as a food element, overdone calcium concentration can lead to the formation of stones in kidneys or gallbladder.

7) Magnesium

Magnesium ions are contributed to hardness. It is the concentration of magnesium ions (Mg^{2+}) present in the water samples. In current study period values of magnesium ranged between 38 mg/L to 53 mg/L which were found within the permissible limits of BIS Standards (as per IS 10500: 2012).

8) Total Alkalinity

Total alkalinity of water is a critical parameter that influences its chemical properties and buffering capacity. Monitoring and managing alkalinity are important for maintaining water quality and ensuring suitability for various uses. According to BIS Standards acceptable limit and permissible limit of total alkalinity are 200-600 mg/L. Total alkalinity of water samples ranged from 440 to 570 mg/L, which is within the permissible limits. It has been observed that alkalinity values act as an indicator of the productive potential of water.

9) Chlorides

Chlorides in water are common and naturally occurring, but elevated levels due to human activities can have implications for water quality and environmental health. Monitoring and managing chloride levels are essential for ensuring the sustainability and safety of water resources. Chloride concentration acts as an indicator of pollution through sewerage. This is the major anions found in water and usually combined with calcium, magnesium and sodium. A desirable limit of 250 mg/L and permissible limit of chloride is 1000 mg/L as per IS 10500 specifications. In present analysis, the amount of chloride present in the water samples varied from 115 to 176 mg/L. The chloride content of the water sample when compared with BIS Standards, it was found that all samples showed concentration within permissible limit.

10) Fluoride

Fluorides in water can have both beneficial and potentially harmful effects depending on their concentration. Monitoring and managing fluoride levels in drinking water are essential for promoting dental health while preventing adverse health effects associated with excessive fluoride intake. Fluoride concentration was found to be between 0.08- 0.12 mg/L and it was lesser than BIS, WHO permissible limits. Excessive intake of fluoride concentration in drinking water may cause fluorosis on human life. The desirable limit and permissible limit of residual chlorine in drinking water is 0.2 to 1 mg/L. It has been observed that excessive amounts of residual chlorine lead to the formation of potentially carcinogenic chloro-organic compounds such as chloroform. In the present study residual chlorine is observed below the detection limits.

11) Biochemical Oxygen Demand

BOD is an essential parameter for assessing the level of organic pollution in water bodies and evaluating the effectiveness of waste water treatment processes. Monitoring and managing BOD levels are critical for protecting water quality and maintaining the health of aquatic ecosystems. The BOD is the requirement of oxygen by microorganisms for the decomposition of organic substances present in water. Therefore, it reflects the amount of organic pollutants in the water.A high BOD value represents the presence of large number microorganisms, which represent high levels of pollution. The results showed that BOD values are quite high in all sampling locations.

12) Chemical Oxygen Demand

COD is a valuable parameter for assessing water quality, pollution levels, and the effectivenessof wastewater treatment processes. Monitoring and managing COD levels are essential for protecting aquatic ecosystems and ensuring compliance with environmental regulations. High COD may lead to degradation of oxygen on account of microbial decomposition to a level detrimental to aquatic life. As per CPCB Effluent Discharge Standards permissible limit of COD for disposal into inland surface water is 250 mg/L. In present study, it was found that COD values varied between 61 to 92 mg/L. Maximum value was recorded at sampling site D-5 and minimum was at sampling site D-15.

13) Nitrate

Nitrate in water refers to the presence of nitrate ions (NO^{3-}), which are a form of nitrogen commonly found in water sources. Nitrate is an essential nutrient for plants and is naturally present in soil and water as a result of biological processes, such as nitrogen fixation by bacteria and the decomposition of organic matter. However, excessive levels of nitrate in water can have environmental and health implications. Increased nitrate concentration in ground and surface water reflects various agricultural activities. High amount of Nitrate-Nitrogen causes different problems such as reduced oxygen levels as a result of the impact on aquatic life, plants and algae. The observed level of nitrate during work was recorded between 68 to 86 mg/L. All investigated samples had values above the permissible limit that prescribed by BIS (45 mg/l) andWHO (10 mg/l). Present study show that water quality of Lasara-Dhanola drain is not safe for drinking and irrigation purposes.

Table 2: Physico-chemical characteristics of surface water of Lasara-Dhanola drain

Sample ID	pH	TDS (mg/l)	Conductivity (µs/cm)	Total Hardness (µg/l)	Turbidity (NTU)	Calcium (µg/l)	Magnesium (mg/l)	Total Alkalinity (mg/l)	Chlorides (mg/l)	Fluorides (mg/l)	BOD (mg/l)	COD (mg/l)	Nitrate (mg/l)
D_1	7.5	850	1700	400	1.29	85	46	500	176	0.10	76	72	74
D_2	7.5	830	1660	380	2.02	90	38	440	116	0.11	81	76	68
D_3	7.4	894	1780	350	11.5	52	53	540	135	0.12	87	77	72
D_4	7.38	896	1796	330	10.0	56	46	500	135	0.11	75	76	81
D_5	7.38	894	1790	310	9.60	56	41	510	120	0.10	152	92	79
D_6	7.35	897	1780	310	9.89	56	41	510	125	0.11	179	90	84
D_7	7.33	897	1785	320	9.56	56	44	520	130	0.11	179	79	78
D_8	7.36	861	1700	310	9.67	52	44	510	115	0.11	113	86	79
D_9	7.55	1004	2000	310	10.0	44	49	570	130	0.10	165	71	85

D_{10}	7.42	863	1720	310	9.68	44	42	550	120	0.08	120	72	86
D_{11}	7.40	869	1727	310	2.51	40	51	500	140	0.11	182	62	72
D_{12}	7.36	865	1760	320	9.8	56	43	470	130	0.11	82	78	70
D_{13}	7.42	867	1767	330	9.5	55	44	480	135	0.11	85	80	75
D_{14}	7.35	897	1790	320	10.2	52	46	490	125	0.10	116	61	79
D_{15}	7.40	865	1760	315	10.0	46	48	540	130	0.10	140	64	76
Mean	7.40	883.26	1767.6	328.3	8.36	56	45.0	508.6	130.8	0.11	122.1	75.7	77.2
SD	0.06	37.97	73.77	27.07	3.26	13.3	4.00	31.80	14.2	0.00	40.2	9.83	5.28
SE	0.01	9.80	19.04	6.99	0.84	3.45	1.03	8.21	3.68	0.00	10.3	2.53	1.36

III. CONCLUSIONS

The use of drain water for irrigation offers a sustainable solution to water scarcity issues in agriculture. But as per the analysis the water of Lasara Dhanola drain is not suitable for irrigation purposes. However, it requires careful planning, treatment, and management to ensure that it is safe and effective. By addressing the challenges and leveraging the benefits, wastewater irrigation can contribute significantly to sustainable agriculture and water conservation. Separating greywater (from sinks, showers, etc.) from blackwater (from toilets) can make treatment easier and more effective. Regular monitoring of water quality and system maintenance is crucial to ensure safety and efficiency. Certain crops are more suitable for irrigation with treated wastewater. Non-food crops or those with minimal direct contact with the edible parts are preferable.

REFERENCES

[1] Indian Standards specification for drinking water, Bureau of Indian Standards (BIS), Second Revision, New Delhi , pp. 1-11 (2012).

[2] Saalidong, B. M., Aram, S. A., Otu, S., & Lartey, P. O. (2022). Examining the dynamics of the relationship between water pH and other water quality parameters in ground and surface water systems. PloS one, 17(1), e0262117.

[3] Chouhan, A. K., Harsh, A., Mishra, D. A. K., Kumar, D. V., Kumar, R., & Kumar, S. Assessment of Groundwater Potential and Quality for Sustainable Development in the Southwestern Part of Bihar State, India.

[4] Dheeraj, V. P., Quaff, A. R., Sonkar, A. K., & Singh, C. S. Suitability Assessment of Ganga River Water for Drinking and Irrigation Purposes in Patna Region, Bihar, India.

[5] Wagh, V., Panaskar, D., Aamalawar, M., Lolage, Y., Mukate, S., & Adimalla, N. (2018). Hydrochemical characterisation and groundwater suitability for drinking and irrigation uses in semiarid region of Nashik, Maharashtra, India. Hydrospatial Analysis, 2(1), 43-60.