PLANNING, ANALYSIS AND DESIGN OF WATER TREATMENT PLANT AT RANGIL DISTRICT GANDERBAL KASHMIR

A Dissertation

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of

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in

Environmental Science and Technology

Submitted by

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*It is to Certify that **Romaisa Ismail,** from **"Department of Energy and Environment, Thapar Institute of Engineering and Technology Patiala, Punjab"** has successfully completed her internship in Jal Shakti, Public Health Engineering Department, Kashmir from **20/09/2023 to 02/07/2024** at Water Treatment Plant, Rangil District Ganderbal. The work and conduct of trainee has remained satisfactory during the period.*

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DECLARATION CUM CERTIFICATE

I hereby declare that the project work entitled "**Planning, analysis and design of water treatment plant at Rangil, district Ganderbal, Kashmir**" is an authentic record of my work carried out at the **Water Supply Master Plan Division, Srinagar Jal Shakti Department (PHE) Kashmir** as requirement of a 10 months project internship for the award of the degree of M.Tech, Environmental Science and Technology, TIET, Patiala, under the guidance of Er. Tabish Jehan Qurieshi, Er. Abdul Majeed and Dr.Shilpi Verma, Mr.K.S Babu during September 2023 to June 2024

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ABSTRACT

This project entails planning, designing and analysis of Rapid sand filtration system to improve water purification ability for rising water needs. The project involves a thorough design stage, which includes choosing suitable materials and determining component sizes, then proceeding with the structured assembly of the filter unit. Key steps involved were building the filter tank, installing an efficient under drain system, layering gravel and sand media of varying grades, and setting up necessary piping and control mechanisms. The project emphasized optimizing filtration performance through careful planning and precise execution of each construction phase. Upon completion, the rapid sand filter is expected to significantly improve water quality. This phase has highlighted the significance of foundational work, such as constructing the filter tank and installing the underdrain system, which are crucial for the stability and efficiency of the entire filtration process. Furthermore, the importance of accurate measurements and meticulous attention to detail when configuring initial piping and control systems has been emphasized by the experience. Understanding the water treatment process revealed the intricate and vital steps involved in converting raw water from natural sources into clean, safe drinking water. Throughout the year, water quality parameters exhibit noticeable variations across different seasons, reflecting the dynamic nature of aquatic ecosystems and the influence of natural and human-induced factors. Seasonal variations in water quality parameters (WQPs) are noticeable due to the interaction of natural processes and human activities with aquatic environments. During the spring season, a rise in precipitation and melting snow can result in elevated turbidity levels caused by sediment being washed into the water. Increased levels of nutrients like phosphates and nitrates from runoff in agriculture can lead to the growth of algae and impact the levels of oxygen in the water. During the summer season, higher temperatures can exacerbate these impacts, possibly resulting in decreased oxygen levels as algae thrive. During the fall season, there is less rainfall and reduced water levels, causing an increase in the concentration of dissolved substances and salts. Winter presents obstacles such as less sunlight and ice formation, which affect oxygen levels and lead to higher concentrations of pollutants.

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CHAPTER- 1

INTRODUCTION

Srinagar City the summer capital of J&K has witnessed a brisk development during the last two to three decades. As the result of this speedy development a number of new housing colonies and other residential areas came into existence. The population of Srinagar City is increasing at a rapid pace and the city is expanding in all directions is very haphazard and unsymmetrical manner thereby increasing the demand of water considerably. Therefore it is clear that the gap between the supply and demand is widening and shall continue to remain so. PHE department is keeping a close watch of the gap and projects have to be framed and implemented at appropriate time to reduce the gap of demand and supply. To fulfill that demand water supply need to be increased but water supplied should be free from contaminants hence raw water is treated first then supplied. Water treatment is the process of removing all those substances, whether biological, chemical or physical, those are potentially harmful to the water supply for human and domestic use. A water treatment plant is a facility designed to improve the quality of water to make it suitable for a specific end-use. This treatment helps to produce water that is safe, potable, clear, colorless and odorless. The main goal of water treatment is to remove impure water residues to make it drinkable. These impurities are responsible for various types of diseases among humans. The main purpose of water treatment is to provide the public with safe access to drinking water free of any contaminants. Treated water is indispensable to modern society. Its importance transcends the basic necessity of hydration, encompassing public health, environmental sustainability, economic stability, and community well-being. By investing in and prioritizing water treatment infrastructure and technologies, we can ensure a healthier, more sustainable and prosperous future for all. As we face global challenges such as population growth, urbanization, and climate change, the role of treated water will only become more critical, underscoring the need for continued innovation and commitment to this vital resource. The ultimate goal of a water treatment plant is to produce water that meets regulatory standards.Rangil filtration plant is one of the largest domestic water supply plants with capacity of 30 MGD serves around 15 lakh population with fresh drinking water. The plant is constructed with atmost design with huge capacity, power supply and equipped lab for testing water quality parameters with qualified staff and plant operating staff, a 24*7check is kept on the water supply to meet water demand of public, since the water comes from a natural source and does not come in contact with any industrial contamination hence the water is quite fit for drinking. Due to growing demand of water additional 5.5 MGD plant has to be constructed to meet the needs of public. Obvious is the fact that water demand of greater Srinagar has increased due to rapid urban agglomeration and also various rural areas have been added to Srinagar city in revised master plan. There by a clear water deficit has got created due to this rapid urbanization, necessitating proactive measures to be taken up by the department of PHE, so as to existing mitigate drinking water supply levels to reach 21 x7 demands of people and up grading of the supply drinking water supply goal for entire Srinagar city by 2024.

1.1 Project Area

Batamallo, Nundresh, Qamerwari, Parimpora, Bemina(E&W), Shaheed Gunj, Karannagar, Chatabal, Nawabazar, AliKadal, Ganpatyar, MRgunj, Khankhai Moulla, Khawajabazaar, SafaKadal, Iddgah, Jamia Masjid, Kawdara, LalBazar, Zadibal, Nowshera, Zoonimar, Soura, Buchpora, Ahmad nagar, Zakura, Hazratbal, Alustang

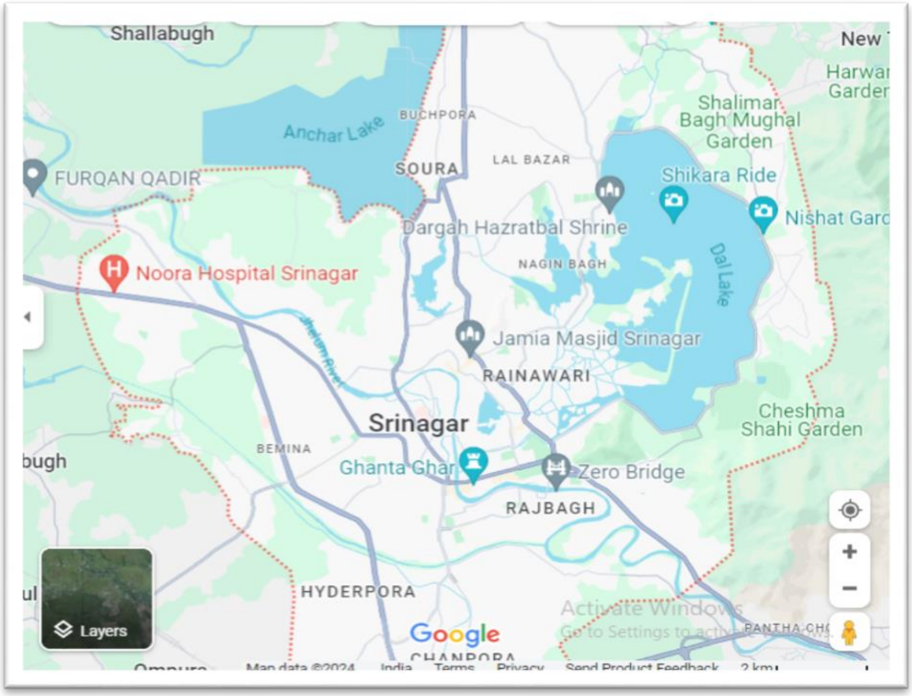


Figure 1.1: Area supplied by plant

Figure 1.2: Google map image of Rangil and its adjoining areas

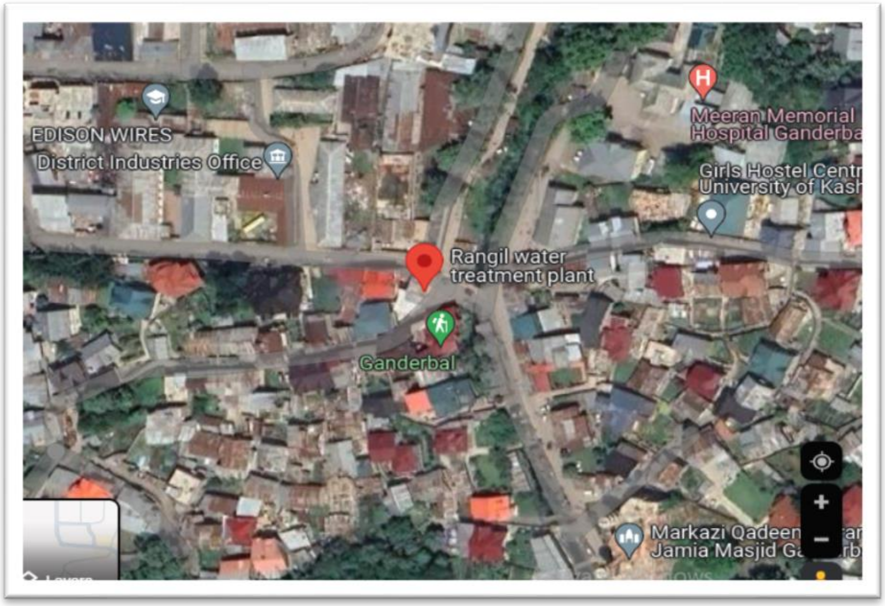


Figure 1.3: Satellite image of Rangil water treatment plant

1.2 SOURCE OF RAW WATER FOR WATER TREATMENT PLANT

The Sindh River is a river in the Ganderbal district of the union territory of Jammu and Kashmir, India. It is a major tributary of the Jhelum River and is 108 km long. The water in the plant comes from Sind_River which runs through the heart of Ganderbal_district.

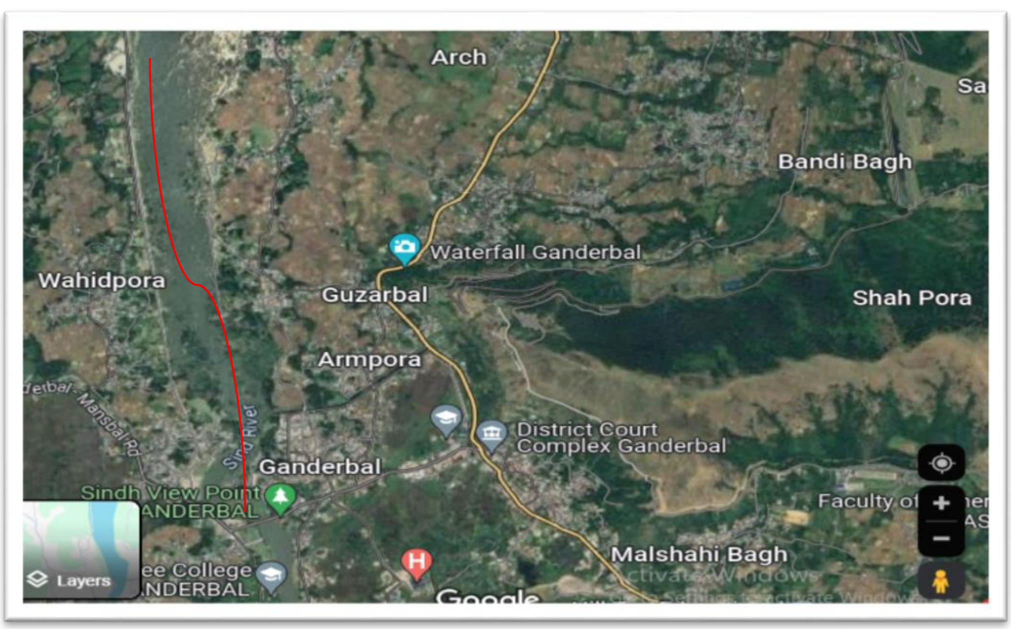


Figure 1.4: Source of raw water River Sindh

1.3 Drinking Water

Drinking water is water that is suitable for human consumption and for household activities like cooking, cleaning, bathing, and showering. The ADWG offers guidance on what defines high-quality drinking water for the Australian community and water supply industry, focusing on both health and aesthetic aspects of water safety. The Australian Drinking Water Guidelines state that drinking water should be clear, colorless, well aerated, free of unpleasant taste or smell, and should not have any suspended particles, toxic chemicals, or disease-causing microorganisms.(11)

1.4 Water Demand

The prediction of water demand for household consumption is very much required to tackle water scarcity. Effective management of water demand involves understanding the needs of various sectors, implementing conservation measures, and utilizing technological advancements. Accurate demand forecasting and proactive management strategies are essential to ensure sustainable water supply for future generations.

1.4.1 Domestic Water Demand

Domestic water demand includes water used for household purposes such as drinking, cooking, bathing, washing, and gardening. The IS code specifies per capita water requirements based on different types of residential areas:

Table 1.1: Minimum domestic water consumption for small Indian towns and cities

Use	Consumption(lpcd)
Drinking	5
Cooking	5
Bathing	55
Washing Clothes	20
Washing Utensils	10
Cleaning of house	10

Flusing of water closets etc	30
Total	**135**

1.4.2 Industrial Water Demand

The water demand for industrial purposes varies significantly based on the type of industry. The IS code suggests that specific water requirements should be estimated based on the nature of the industrial processes involved.

Table 1.2: Water demand of certain commercial establishments

Use	Consumption(lpcd)
Offices	45
Schools	45 to135
Hostels	135
Hotels	180
Hospitals	450
Cinema halls	15

1.4.3 Fire fighting Demand

Water demand for firefighting purposes is an important consideration for urban water supply planning. The IS code specifies firefighting demand based on the population of the town or city.

1.4.4 Public Use and Other Demands

Public use water demand includes water for public facilities such as parks, gardens, street cleaning, and public fountains.

1.4.5 Losses and Unaccounted-for Water

Water losses in the distribution system, often referred to as unaccounted-for water (UFW), must also be considered. These losses can be due to leaks, unauthorized connections, and operational inefficiencies. The IS code recommends that water supply systems should aim to minimize losses, typically estimating a provision of around 15-20% of the total water demand

1.5 Population Forecasting Methods

i. Arithmetical increase Method

ii. Geometric increase method

iii. Incremental Increase Method

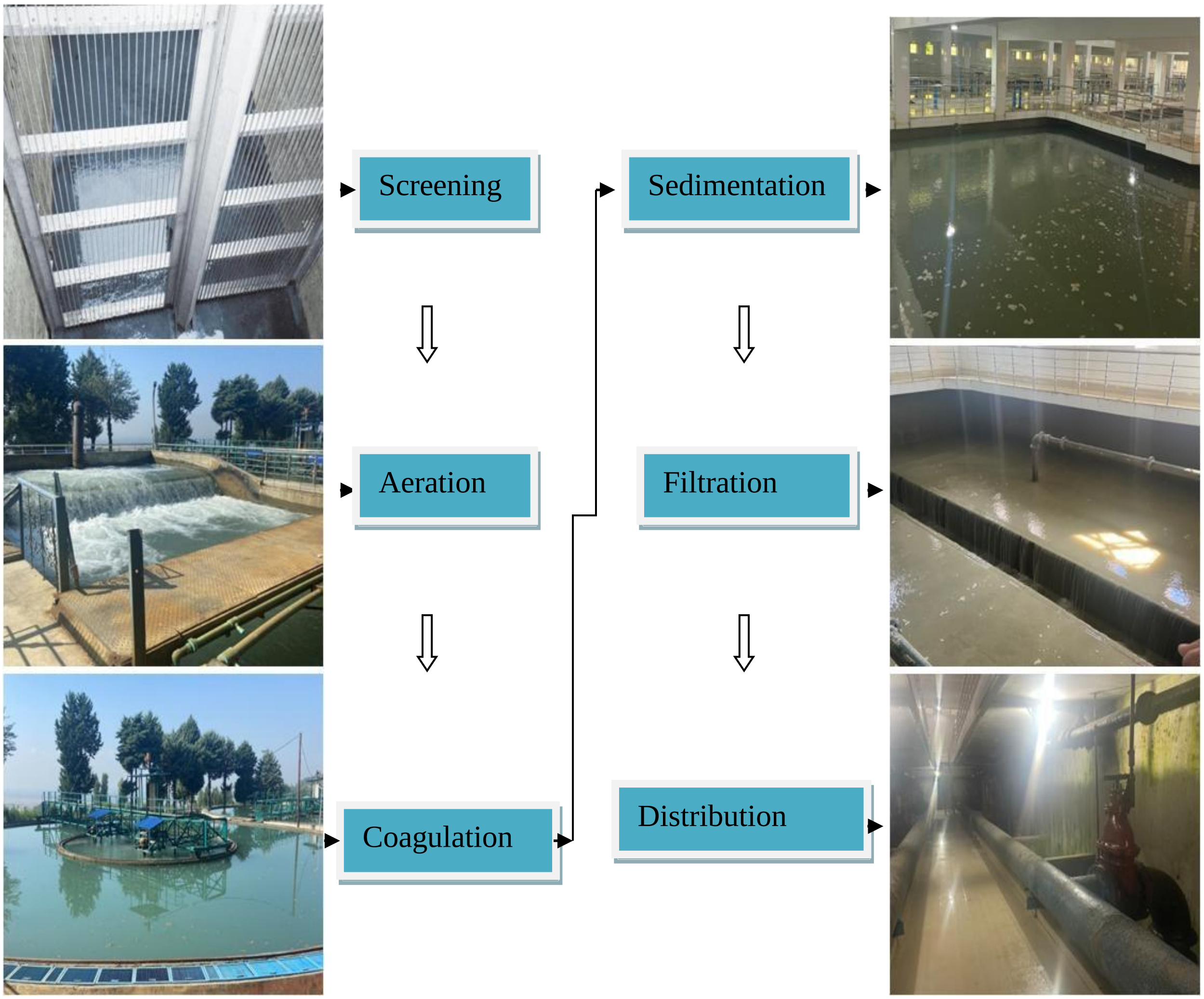
iv. Decreased Rate of Growth/Changing Rate of Increase Method

v. Master plan method

1.6 Water Treatment Plant

Water treatment plant for drinking water is designed to remove contaminants from raw water to produce water that is safe for human consumption. The treatment process involves multiple stages, each targeting specific types of impurities. Water treatment is the process of removing all those substances, whether biological, chemical or physical, those are potentially harmful to the water supply for human and domestic use. This treatment helps produce water that is safe, palatable, clear, colorless and odorless. Due to fast urban growth and industrial development, the need for top-notch water has sharply increased, highlighting the importance of advanced treatment methods to satisfy these requirements. Modern water treatment facilities also have a crucial function in safeguarding the environment by purifying sewage before releasing it into freshwater sources, effectively avoiding contamination and conserving aquatic habitats. Furthermore, they contribute to economic growth by supplying water for industrial operations, farming, and other essential industries. Amidst climate change and water scarcity, it is crucial to implement innovative treatment techniques and effective management strategies for sustainable water resource management, guaranteeing access to this vital resource for both present and future generations. Treatment process follows series of steps.

Depiction of water treatment stages at Rangil filtration plant:



1.6.1 Screening

Using screens to eliminate large floating and suspended solids in the inflow is essential to safeguard the primary treatment plant unit and ensure its effective functioning. These items consist of leaves, twigs, paper, rags, and various debris that may impede the plant's flow or harm equipment.(14)

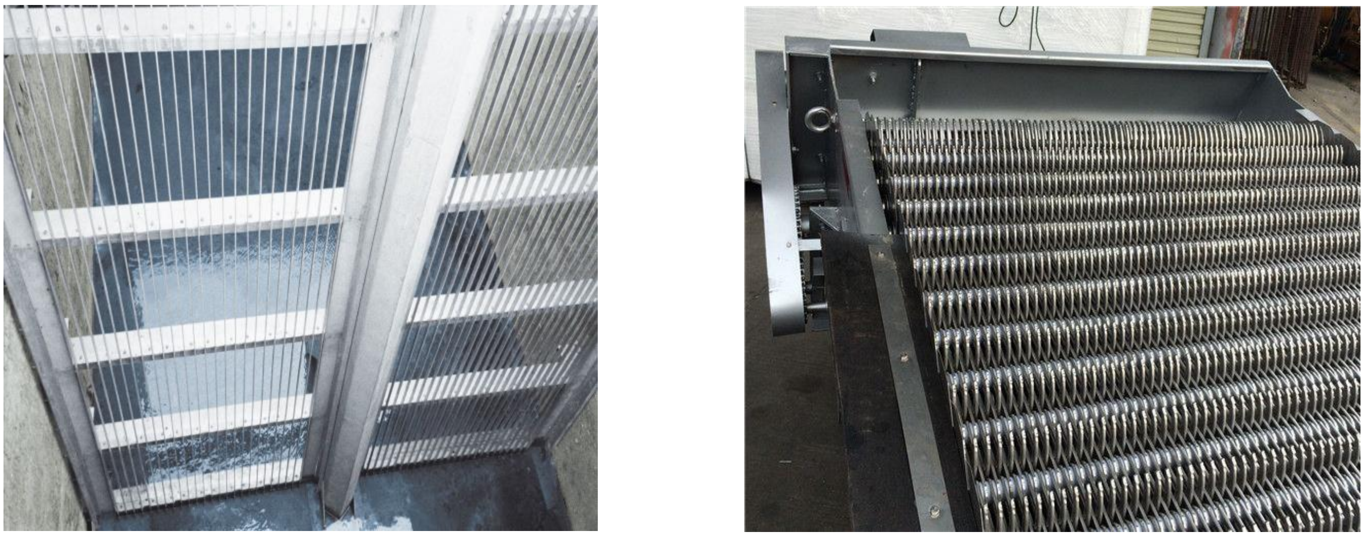


Figure 1.5: Coarse screen and Fine Screen

1.6.2 Aeration

Following filtration, the water passes through multiple stages to take in oxygen from the atmosphere and undergo aeration. This procedure aids in eliminating dissolved gases like carbon dioxide and hydrogen sulfide (both of which are acidic, decreasing the water's corrosiveness) and gaseous organic compounds that cause an unpleasant flavor in the water. It eliminates all substances..Oxidation by aeration also eliminates iron or manganese by converting them into forms that are not soluble. Iron and manganese can lead to a distinct flavor and result in staining of clothing. Once these materials have turned into an insoluble state, they can be filtered out.(14)

Figure 1.7: Aeration

1.6.3 Coagulation and Flocculation

Following aeration, small particles suspended in the water are gathered and eliminated. During this procedure, a positively charged chemical known as a flocculants is introduced into the water in order to counteract the negative electrical charge of the particles. Coagulant is added in a high-speed mixing tank, where a high-speed impeller quickly spreads the coagulant. Once the charge is balanced, the particles come together to create gentle, airy clusters known as "clots." Aluminum sulfate and ferric chloride are both frequently utilized coagulants in the field of water treatment. The subsequent stage involves flocculation. In this step, paddles softly mix the water in a flocculation basin, allowing the flocs to merge and create bigger flocs. The ten-compartment flocculation basin features reduced mixing speeds as water moves through it. This sectioned chamber enables larger flocs to form without getting disrupted by the stirring.(14)

1.6.4 Sedimentation

Once big clots have developed, they need to be given time to settle. This process, known as settling, involves storing water in a tank after coagulation and flocculation to allow precipitation to happen over a few hours. The sludge is the term used for the substance that gathers at the tank's base. This will be taken away for disposal. Sedimentation processes help decrease the amount of particles in water. Settling is beneficial because it decreases the necessity for flocculation or coagulation, which typically involve chemicals, but better settling can help reduce the amount of additional chemicals needed. Furthermore, sedimentation may serve to enhance the efficiency of ongoing filtration when used following coagulation. While precipitation is a recognized procedure within the water treatment sector, it is still considered hypothetical. The procedure may differ based on the level of particles present. For instance, in low doses, they frequently sink freely or without any need for manual help. As the level of concentration rises, the obstacles to settling also rise, necessitating additional assistance to facilitate the process.

Figure 1.8: Sedimentation tank

1.6.5 Filtration

Separating solids from liquids is the procedure of filtration. Water treatment uses sand or gravel to filter out solids that weren't removed in the settling basin. Backwashing is typically performed on high-speed gravity filters when they become filled with absorbed solids, and they are commonly operated at a flow rate of 4 to 8 cubic meters per square meter of filter surface per hour. During this procedure, filtered impurities are removed as clean air is pushed back into the filter, while the collected dirty water, known as backwash, is directed into the sewer system if available. In contrast, it could be sent back to the original river following a settling process in a settling tank to transport solids. Filtration is the next stage in traditional water treatment processes, where suspended particles are eliminated from the water through pressure into a porous material. Filtration systems comprise filters of different sizes of pores, usually made up of sand, gravel, or charcoal. The illustration below displays a filter made up of variously sized particles. Rapid sand filtration eliminates suspended particles with potentially attached bacteria, but typically does not eliminate bacteria, protozoa, or viruses. the same language that you used in the text and keep the same length of words and phrases.
Water treatment facilities remove many pollutants through filtration, yet disinfection is still necessary to ensure safe drinking water. Despite its limitations in removing bacteria and viruses, rapid sand filtration plays a crucial role in the water treatment procedure. Filtration also protects downstream equipment and processes by preventing clogging and damage, reducing maintenance costs, and enhancing overall system efficiency. Additionally, it plays a crucial role in safeguarding public health by providing clean, potable water to communities.Similar to coagulation, filtration is able to eliminate the suspended solids. Filter beds are cleaned time to time to avoid coagulation of openings. Staff keeps a regular check of this in order to avoid dysfunctioning of plant.

Figure1.9: Filter beds

1.6.6 Chlorination

Once it has settled, the water is treated to eliminate any remaining harmful microorganisms. Chlorine, liquids like sodium hypochlorite, and gases are the most frequently used disinfectants. It is quite affordable and simple to utilize. Adding chlorine to water causes a reaction with contaminants, such as microorganisms, during a specific time frame known as contact time. The chlorine left over is referred to as residual chlorine. The chlorine continues to stay in the water system, safeguarding it against harmful microorganisms until it is delivered to the consumer.. In water with a concentration of 5 mg/L, the residual chlorine level must not drop below 0.5 mg/L after 30 minutes of contact time .Different methods exist for water disinfection, such as ozone gas or ultraviolet rays. Nevertheless, once it has left the treatment plant, they are unable to safeguard the water against microbial contamination. Once the water has been disinfected, it is then sent into the water distribution system for circulation.

1.6.7 Storage and Distribution

Following treatment, water is kept in transparent wells or reservoirs. Then it is pushed into the distribution system, consisting of a series of pipes, tanks, and stations to transport water to customers. Efficient ways of delivering and storing water are crucial parts of a dependable and secure water supply infrastructure. They make sure that clean water is delivered to consumers in a timely manner and is accessible when required. Pipelines serve as the main structure of the distribution system, carrying water from treatment facilities to users. Materials like ductile iron, PVC, or steel can be selected depending on factors like longevity, price, and appropriateness for the area. Pumping stations increase water pressure in the distribution network to allow water to reach elevated and remote locations. Many times, extensive distribution networks are segmented into zones for controlling pressure, identifying leaks, and isolating areas for maintenance without impacting the entire system. These are spacious storage sites, usually situated in close proximity to treatment plants, where treated water is stored prior to being distributed. Reservoirs play a role in stabilizing supply and demand by offering a cushion during periods of high demand or emergencies.(8)

1.7 Characteristics of water:

Knowledge of water properties is crucial for developing and managing a successful rapid sand filtration facility. Key factors of water to be taken into account are its physical, chemical, and microbiological attributes. These features impact the choice of treatment methods and the effectiveness of the filtration system.Water characteristics which are determined after treatment and before supply are as follows:

1.7.1 Physical Characteristics

- **Turbidity:** This counts for the cloudiness or haziness of water, often caused by suspended solids. High turbidity can harbor pathogens and interfere with disinfection.
- **Color:** Ideally, drinking water should be colorless. Any coloration might indicate the presence of organic material or metals.
- **Taste and Odor:** Drinking water should be free from any taste or odor. Unpleasant tastes or odors can be caused by organic matter, chlorination, or industrial contaminants.(8)

- **Temperature:** While not a direct health concern, water temperature can affect taste and chemical reactions. Typically, cooler water is more palatable.

1.7.2 Chemical Characteristics

- **pH:** The pH of drinking water must range be between 6.5 and 8.5. Water which is too acidic or too alkaline can cause corrosion of pipes and fixtures and may have a metallic taste.
- **Hardness:** Hard water has high levels of calcium and magnesium. While not harmful, it can cause scale buildup in pipes and reduce the effectiveness of soap.
- **Total Dissolved Solids (TDS):** This evaluates the total amount of inorganic and organic materials in water. Elevated TDS concentrations can impact flavor and might suggest the existence of dangerous pollutants.
- **Chlorine:** Used as a disinfectant, chlorine levels in drinking water should be carefully controlled. While effective at killing pathogens, high levels can produce by-products that may pose health risks.
- **Fluoride:** Added to prevent tooth decay, fluoride levels should be monitored to avoid dental and skeletal fluorosis.
- **Nitrates and Nitrites:** Often originating from agricultural runoff, high levels can cause health issues, particularly for infants (blue baby syndrome).
- **Metals:** Contaminants like lead, arsenic, mercury, and cadmium are highly toxic and must be kept below regulatory limits.(8)

1.7.3 Biological Characteristics

- **Pathogens:** Drinking water is expected to be free from harmful microorganisms such as bacteria (e.g., E. coli), viruses, and protozoa. These pathogens can cause a range of illnesses.
- **Coliforms:** Coliform bacteria serve as a measure of water quality and can indicate the possible existence of pathogens. Their existence indicates possible contamination of water with fecal matter.

- **Viruses:** Viruses are the tiniest biological entities with complete genetic material for self-replication. They are only visible under a high-powered electronic microscope. The disinfection process carried out at the water treatment plant can deactivate the majority of waterborne viruses.(8)

Table 1.3: Water quality parameters and IS: 10500 - 1991 standards for various physical,chemical and biological parameters.

Parameters	Permissible Limit	Maximum Limit
Odor	Agreeable	Agreeable
Taste	Agreeable	Agreeable
Ph	6.5 to 8.5	No relaxation
TDS (mg/l)	500	2000
Hardness (as CaCO3) (mg/l)	200	600
Alkalinity (as CaCO3) (mg/l)	200	600
Nitrate (mg/l)	45	No relaxation
Sulfate (mg/l)	200	400
Fluoride (mg/l)	1	1.5
Chloride (mg/l)	250	1000

Turbidity (NTU)	1	5
Arsenic (mg/l)	0.01	No relaxation
Copper (mg/l)	0.05	1.5
Cadmium (mg/l)	0.003	No relaxation
Chromium (mg/l)	0.05	No relaxation
Lead (mg/l)	0.01	No relaxation
Iron (mg/l)	1	No relaxation
Zinc (mg/l)	5	15
E.Coli (cfu)	0	0

CHAPTER- 2

LITERATURE REVIEW

2.1 Water Demand

Urbanization has a major impact on water demand because of the growing population density in urban areas. As cities grow, the need for water in residential, commercial, and industrial sectors also increases. Factors like improved living standards, heightened economic activities, and the expansion of water-demanding services and industries are fueling this growth. Moreover, city living commonly results in increased water usage per person in comparison to countryside regions. The rapid growth of urban areas often results in a mismatch between demand and infrastructure capacity, causing difficulties in providing water supply and distribution. A review delves into the different trends and factors that impact urban water demand. The writers examine data from various studies to pinpoint main factors influencing water usage in cities, such as population increase, economic progress, climate shifts, and technological progress. The review also assesses how policy measures and water pricing affect demand patterns. The results emphasize the intricate nature of urban water consumption patterns and stress the importance of using comprehensive management strategies to guarantee a stable water source in expanding urban regions.(1)

Table 2.1: Studies on rapid sand filter, water quality parameters to improve water quality.

S.No:	Author and Title	Parameters	Findings	References
1.	Smith *et al.*, 2023 Urban Water Consumption.	Raising water demand and effects of urbanization on it.	Examining prior studies to emphasize main urban water usage trends, consequences of population increase and urban development, influences of climate change on water supply, and the	(1)

			efficiency of water-saving strategies.	
2.	Brown *et al.*, 2020 Forecasting residential water demand under demographic changes.	Approaches for predicting household water usage, like statistical models, time-series analysis, or scenario planning methodologies.	The study probably talks about results on how demographic shifts affect water usage habits, focusing on aspects such as population growth, household size, income type.	(2)
3.	Gupta *et al.*, 2021 Performance evaluation of a rapid sand filtration plant for drinking water treatment.	Assess the efficiency and effectiveness of rapid sand filtration in removing particulate matter, pathogens, and other contaminants from raw water sources.	Presents findings on the removal capabilities of different contaminants, including turbidity levels, microbial counts, and particle size distribution, before and after filtration.	(3)
4.	Jones *et al.*, 2022 The role and necessity of rapid sand filters in modern water treatment plants.	Focuses on evaluating the role and necessity of rapid sand filters (RSFs) in contemporary water treatment plants.	The authors recommend integrating RSFs with pre-treatment processes (e.g., coagulation and flocculation) to enhance performance.	(4)
5.	Nguyen *et al.*, 2021 Design and construction of rapid sand filters for urban water treatment plants.	Detailed guide on the design parameters, construction techniques, and operational considerations for implementing rapid sand filters in urban water	Recommends that optimizing the filter bed depth and media size significantly improves filtration efficiency.	(5)

		treatment settings.		
6.	Patel *et al*., 2020 Development and application of Water Quality Index (WQI) for surface water quality assessment.	The study is to develop a robust WQI that integrates multiple water quality parameters into a single index.	The study found significant spatial and temporal variations in water quality along the Sabarmati River.	(6)
7.	Gupta *et al*., 2019 Ensuring access to clean drinking water: Challenges and solutions.	Study aims to identify and evaluate the various challenges in reference with providing clean drinking water globally and propose practical solutions to overcome these challenges.	Study found that microbial contamination and chemical pollutants are major threats to water quality. Lack of education, and inadequate governance were identified as significant barriers.	(7)
8.	Brown *et al*., 2019 Assessment of Water Quality Parameters in Freshwater Systems	The study is to review and analyse key water quality parameters essential for assessing freshwater systems' health.	Found that excessive nutrient levels, primarily from agricultural runoff, led to eutrophication, and high microbial indicators were linked to sewage contamination, posing significant health risks.	(8)
9.	Singh *et al*., 2021 Identification and assessment of critical parameters affecting drinking	Study aims to identify and evaluate the critical parameters that influence drinking water quality in various water treatment plants in India.	The critical parameters affecting drinking water quality in India requires a multifaceted approach involving advanced technologies, stringent	(9)

	water quality.		monitoring, and robust policy frameworks.	
10.	Koley *et al*., 2021 Identification and assessment of Critical parameters affecting drinking water quality.	Study aims to identify and evaluate the critical parameters influencing drinking water quality in various water treatment plants across India.	Findings emphasize the need for stringent monitoring and advanced treatment technologies to ensure the provision of safe drinking water.	(10)

2.2 Rapid Sand Filtration

Rapid sand filtration offers several benefits for drinking water treatment. It efficiently removes suspended solids, turbidity, and microbial contaminants from raw water, thereby improving water clarity and safety. Rapid sand filters are strong, dependable, and able to effectively manage different water quality conditions. By offering dependable disinfection, they help maintain consistent water quality standards and adhere to regulatory requirements. A study was conducted to evaluate the performance of a rapid sand filtration plant used for drinking water treatment. It focuses on assessing the effectiveness of the filtration process in removing contaminants and ensuring the quality of treated water, rapid sand filtration plant showed high efficiency in removing turbidity from raw water, meeting or exceeding regulatory parameters.(3)

2.3 Efficiency of Rapid Sand Filter

Rapid sand filters are very effective at enhancing the quality of drinking water by efficiently eliminating turbidity, suspended solids, and microbial contaminants. They function by running untreated water through a layer of sand, where impurities and small organisms are captured, leading to cleaner and safer drinking water. Research has demonstrated that rapid sand filters can lead to considerable decreases in turbidity and bacterial levels, frequently meeting or surpassing regulatory requirements for safe drinking water. Their effectiveness is also improved due to their capacity to manage high quantities of water while requiring minimal operational expenses and maintenance needs. Moreover, rapid sand filters can be seamlessly incorporated into current water treatment systems, offering flexibility and an effective way to maintain uniform water quality in different environments. In modern water treatment processes, rapid sand filters are essential due to their high efficiency and reliability. A study emphasized their essential role in eliminating particles, cloudiness, and harmful microorganisms from untreated water, guaranteeing the provision of safe and clear drinking water. The authors also look at real-life examples that show how efficient rapid sand filters are in different locations and situations, the difficulties of keeping the filters working well, and the possibility of combining rapid sand filters with other advanced treatment methods. The review ends by suggesting ways to improve fast sand filter operations to keep up with the changing requirements of current water treatment.(5)

2.4 Water Quality Index

Water Quality Index (WQI) is a method used to evaluate the overall water quality by considering various physical, chemical, biological, and occasionally microbial factors. It gives one numerical value to show water quality that is easily understood by policymakers, water managers, and the public. The creation and use of a specialized Water Quality Index (WQI) to evaluate the quality of surface water in the river was done. A holistic WQI model was developed by incorporating different physicochemical parameters like pH, DO, BOD, COD, turbidity, TDS, and levels of nutrients and heavy metals. The model was then used at various locations along the Sabarmati River to assess how well it reflected the river's overall water quality. Findings showed notable differences in water quality across different areas, pointing out regions with severe pollution levels. The WQI was shown to be a useful tool for simplifying intricate water quality information into a clear and actionable format, which helps improve water management and policy decisions. The research highlights the significance of ongoing surveillance and proposes possible ways to enhance the water quality of the River. (6)

2.5 Water Quality Parameters

Water quality parameters (WQPs) are crucial measurements used to assess the state and appropriateness of water for different purposes like drinking, farming, and industry.

Temperature and turbidity are important physical factors that impact both aquatic life and water clarity. Chemical parameters such as pH, DO, BOD, and nutrient and heavy metal concentrations play a vital role in determining the chemical composition and potential toxicity of water. Biological factors, such as microbial markers, indicate the existence of dangerous germs. These parameters collectively offer a thorough grasp of water quality, directing management practices and policies for ensuring the safety and sustainability of water resources. Research examines various treatment facilities' data to pinpoint main pollutants and issues that affect water quality. The research is centered on chemical factors like nitrate, phosphate, and heavy metals, in addition to microbial impurities such as coliform bacteria. The evaluation also considers physical factors such as turbidity and pH levels. The results show important differences in water quality, underscoring the importance of strict monitoring and advanced treatment methods. The writers offer suggestions for enhancing treatment methods and regulatory structures to guarantee the delivery of safe drinking water. Observation suggested that parameters keep on changing due to temperature variations which can be due to runoff, precipitation, freezing etc. (8),(9)

2.6 Objectives

On the basis of literature review following objectives were aimed.

- Gain a thorough understanding of the execution/ installation of rapid sand filter at Rangil to cater the increased water demand of public.
- Conduct and analyze the water quality parameters to ensure compliance with regulatory standards and identify any deviations.
- Decipher the reason for changes in water quality parameters during work period.

2.7 Scope

The aim of rapid sand filtration plant at Rangil is to meet increasing public water demand. A water filtration plant is a facility that filters and purifies water by eliminating pollutants, dangerous contaminants, and poisonous substances. The WFP's goal is to remove unwanted material and create water fit for human consumption. From feasibility studies and design support to water quality analysis and regulatory compliance, involvement will help to develop a comprehensive understanding of the complexities involved in planning and developing a water treatment plant. Involvemnet also provides a understanding of both the theoretical and practical aspects of water treatment.A rapid sand filtration plant is a cornerstone of water treatment infrastructure, providing an essential service in ensuring the clarity and safety of water. Its efficiency, cost-effectiveness, and ability to handle large volumes of water make it indispensable in municipal, industrial, and agricultural settings. Collecting and analyzing water samples to measure key parameters fosters a strong foundation in water quality testing, additionally, interpreting the data to assess water quality and identifying potential sources of contamination develops critical thinking and problem-solving abilities.

CHAPTER - 3

Material and Methods

Thereby a clear water deficit has got created due to rapid urbanization so to mitigate drinking water supply demand and upgrading the supply levels proactive measures were taken up by PHE department. Below table depicts the ward wise population for areas feeding from Alusteng & 20 MGD Rangil WTP based on census 2011 and extrapolated to 2031 and 2041.The growth rate are based @ 2.6 per annum as adopted by SDA in their revised Master Plan 2017-2035. Accurate population forecasting is crucial for effective water demand planning and management. As populations grow and urbanize, the demand for water increases, necessitating precise predictions to ensure sustainable water supply systems. Population forecasting involves analyzing demographic trends, migration patterns, birth and death rates, and economic development to project future population sizes and distributions. This information helps water utilities and planners estimate future water needs, design appropriate infrastructure, and implement efficient water resource management strategies. Anticipating increased demand allows for timely investments in water treatment facilities, distribution networks, and storage capacities, ensuring that supply can meet the needs of both current and future residents. Moreover, population forecasting aids in identifying potential shortages or surpluses, enabling proactive measures such as conservation programs, demand management, and the exploration of alternative water sources.

Table 3.1: Ward wise population for areas

Name of ward	Population as per census 2011	Projected population for year 2021	Projected population for year 2031	Projected population for year 2036 for assessing drinking water requirement	Projected population for the year 2041
Batmallo(partly)	8071	10433	13486	15332	17432
Nund Resh colony	7719	9978	12898	14664	16672
Qamerwari	8469	10947	14151	16089	18292
Parimpora	8879	11348	14669	16677	18961
Bemina E	7912	10227	12220	15030	17089
Shaheed Gunj	9302	12024	15543	17671	20091
Karanagar	11906	15390	19894	22618	25715
Chatabal	17304	22368	28913	32872	37374
Syed ali akbar	16347	22131	27314	31054	35307
Nawabazar	14546	18803	24305	27633	31417
Islamyarbal	11501	14867	19217	21849	24840
Ali kadal	8813	11392	14726	16743	19035
Ganpatyar	13116	16954	21915	24916	28328
Barbasha partly	9002	11636	15041	17101	19433

Khan Khai Moula	16617	21480	27764	31566	35888
MR Gunj	18242	23580	30480	34654	39398
Khawaja bazaar	17496	22616	29233	33236	37787
Safa Kadal	19855	25665	33175	37718	42882
Iddgah	26574	34350	44400	50480	57394
Jamia masjid	8601	11118	14372	16340	18577
Kawdara	23493	31531	40757	46388	52683
Madin sahib	13300	17192	22223	25266	28727
Lal bazaar	22070	28528	36876	41926	47666
Zadibal	15593	20156	26054	29622	33678
Nowshera	12091	15692	20202	22968	26114
Zoonimar	15408	19917	25744	29269	33278
Soura	11636	15042	19443	22105	25132
Buchpora	22525	29116	37637	42791	48649
Ahmad nagar	30529	39462	51009	57994	65935
Zakura	11791	15241	19702	22400	25467
Hazratbal	18942	24485	31650	35984	40909

Alustang	17506	22629	29251	33257	37809
TOTAL	488554	632683	817818	929805	1057122
Floting population	25714	33297	43040	48934	55635
Grand Total	514268	665980	860858	978739	1112757

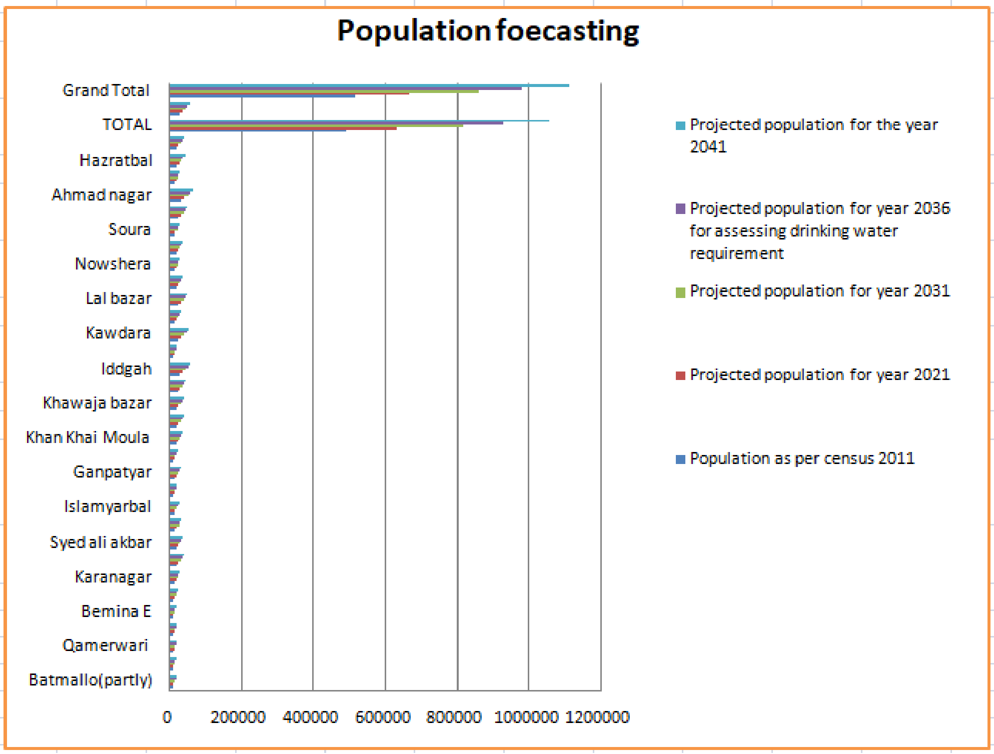


Figure 3.1: Population forecasting

Expected Available Capacity of Alusteng & Rangil 20 MGD after revamping = 24.0MGD.

Demand of water based on the manual CPHEEO 1999 clause 2.2.8.3 recommendations for city with drainage facility, drinking water supply has to be @135lpcd plus a UFW of 15%(@155LCD) in respective years is

Year-2021 = 665980 Souls @155 Ipcd=22.85 MGD

Year -2031= 860858 Souls @1551pcd=29.53 MGD

Year -2036= 978739 Souls @1551pcd=33.57 MGD

Year-2041 =1112757 Souls @1551pcd=38.16 MGD

- Besides, rapid urbanization demands a separate provision for 24×7 drinking water supply to ever growing hospitals @ 450 lpcd per bed as well as the firefighting demand of water.
- The Present cumulative demand of these hospitals @450lit per bed as per CPHEEO manual recommendations works out as 0.42MGD which is expected to rise to 0.75 MGD by the end of 2041.
- Provision for firefighting demand in Kilo litres evaluated as per recommendations of CPHEEO manual 1999, ie 100vP Where P is Population in thousands is around 0.25 MGD

  for 2021, 0.29 MGD for 2031, 0.32 MGD for 2036 and 0.56 MGD for 2041.
- Based on these analysis, following cumulative demand is arrived at to provide 24*7 drinking water supply to areas feeding from Rangil 20 MGD & Alusteng:

Year-2021: 23.52+0.42+0.25 = 23.52 MGD

Year-2031: 29.53+0.56+0.29 = 30.38 MGD

Year-2036: 33.57+0.61+0.32 = 34.50 MGD

Year-2041: 38.16 +0.75 +0.56 =39.47 MGD

3.1 Population forecasting

i. **Arithmetical increase Method:** In this method, the increase in population after 10 yeras is assumed to be constant.

$$Pn = P0 + nC$$

Where, P0 = Population at the initial year

Pn = Population at the nth decade

n = no of decades

C = average increase in population for 10 years.

ii. Geometrical Increase Method: In this method, the percentage increase in population per decade remains constant for each future decade.

$P_n = P_0 (1+(r/100))^n$

Where, P_0 = Population at the initial year

P_n = Population at the nth decade

n = no of decades

r = average percentage increase in population in 10 years

iii. Incremental Increase Method:

$P_n = P_0 + nC + (nC' (n+1))/2$

Where, P_0 = Population at the initial year

P_n = Population at the n th decade

n = no of decades

C = average increase in population for a 10 years

C ' = average incremental increase in population for 10 years.

iv. Decreased Rate of Growth/Changing Rate of Increase Method:

$P_n = P_0 (1+ (r_n – r')/100) (1+(r_n – 2r')/100)….(1+(r_n – nr')/100)$

Where, P_0 = Population at the initial year

P_n = Population at the nth decade

n = no of decades

rn = percentage increase in population in the last 10 years

r ’ = average decrease in percent increase in population per decade

v. Graphical Method: Extension Method **and** Comparison Method

vi Miscellaneous Method: Master Plan Method

3.2 Materials

The construction of water treatment plants involves the use of various equipment to ensure effective and safe water treatment. Specific information may vary depending on the design, location and technology of the water treatment plant. However, some of the materials used in the construction of water treatment plants are:

3.2.1 Excavation: Earth work in bulk by hydraulic excavator was done (areas exceeding 30cm depth, 1.5cm in width as well as 10 m sq on plan) including disposal of excavated earth lead upto 50 meters and lift upto 1.5m.

Table 3.2: Items and Numbers

Items	Number
Columns: :	8
Clariflocculator	
Flocculator:	2
Central shaft:	2
Washout pipes:	2
Inlet pipe:	2
Flash mixer	2
/Intake	
Chamber	
Distribution box	3
Clean water	
Intake Chamber	3
Raw water	
Supply main	

pipe Column/pillar Saddle block	25 30

3.2.2 Basic construction materials used

Observation and record maintained in construction of water treatment plant

- Providing and laying dry stone soling in foundation trenches hand packed and consolidated by hand ramming (Quarry).
- Providing and laying in position cement concrete of specified grade excluding the cost of cantering and shuttering
- Providing and laying at position specified grade of reinforced cement concrete work in walls (any thickness) including attached pilasters, buttresses, plinth and string courses, fillets, columns, pillars, piers, abutments, posts and struts up to floor five level including curing but excluding cost of centering shuttering, finishing and reinforcement (M 30) crushed aggregate.
- Providing and filling sand under filter beds including dressing, ramming and all carriages.
- Reinforcement for R.C.C. work including straightening, cutting, bending, placing in position and binding al complete (TMT bars).
- Brick work with common burnt clay (non-modular) bricks of class designation 75. In foundation and plinth including curing.
- 18mm Cement plaster in two coats under layer 12mm thick cement plaster 1: 5 (1 cement: 5coarse sand) finished with a top layer 6mm thick cement plaster.
- Structural steel work welded in built up sections, trusses and framed work, including cutting, hoisting, fixing in position and applying a priming coat of approved steel primer al complete.
- Carriage of materials by Mechanical Transport including loading, unloading and stacking from divisional store to dumping site.

3.3 Laboratory methods

To determine and analyze water quality parameters laboratory methods were used.

3.3.1 Turbidity test

To determine the turbidity of water Nephelometric Method was used. The nephelometric method is a reliable and widely used technique for measuring the turbidity of water samples. Turbidity is a amount of the cloudiness or haziness of a liquid caused by suspended particles.

- **Calibrate the Nephelometer**: Before measuring samples, the nephelometer was calibrated using standard solutions of known turbidity.
- **Preparation of Standards**: Use turbidity standards with known turbidity values (e.g., 0, 10, 100 NTU) to calibrate the instrument.
- **Sample Collection**: water samples were collected in clean, non-reactive containers to avoid contamination. Handled the samples carefully to prevent introducing bubbles or additional particles.
- **Insert Sample**: sample is placed into the nephelometer. Make sure the sample vial is clean, free of scratches, and properly aligned in the instrument.
- **Measure Turbidity**: Close the instrument lid and record the turbidity reading displayed by the nephelometer. This reading is usually given in Nephelometric Turbidity Units (NTU)

3.3.2 Total Hardness

Total hardness of water sample was determined by Titration Method was used. Titration is a common method for determining the total hardness of a water sample, which is primarily due to the presence of calcium and magnesium ions. The EDTA (ethylene diamine tetraacetic acid) titration method is widely used for this purpose.

- **Preparation of Sample:** water sample is collected in a clean container.
- **Buffer Solution:** 1-2 ml of the buffer solution is kept to the conical flask. This ensures the pH is around 10, which is optimal for the EDTA titration.
- **Indicator Addition:** Few drops (3-4) of Eriochrome Black T indicator are mixed to the water sample in the conical flask. The solution will turn wine red if hardness ions are present.

Titration:

- Burette is filled with the EDTA solution.
- Initial reading of the burette is noted.
- Slowly the EDTA solution is added from the burette to the water sample while continuously swirling the conical flask.
- EDTA is continuously added until the color transforms from wine red to a clear blue, indicating that all hardness ions have reacted with the EDTA.
- **End Point Determination:** Final reading of the burette is noted when the color transform is complete. The volume of EDTA used is the difference between the initial and final readings.

3.3.3 Total dissolved solids

To determine the TDS the conductivity method was used. The conductivity method is a common and quick way to estimate the TDS present in a water sample. The overall amount of dissolved solids in water, known as Total Dissolved Solids (TDS), is directly linked to the water's electrical conductivity (EC) because higher levels of dissolved ions enhance the water's electrical conductivity.

Calibration: Standard solutions with known conductivity values are used to calibrate the conductivity meter.

Sample Preparation: Water sample is collected in a clean container. Make sure the sample is at a stable temperature, ideally around 25°C, as conductivity is temperature-dependent.

- **Measurement:** Rinse the probe of the conductivity meter with distilled water and then immerse it into the water sample. Ensure the probe is completely immersed and free of any air bubbles in its vicinity.
- Wait for the reading might need some time to stabilize, ranging from a few seconds to a minute.

Calculate TDS:

- Use the TDS conversion factor to convert the conductivity reading to TDS. The conversion factor varies depending on the water composition but is generally in the range of 0.5 to 0.7.

TDS= Conductivity × Conductivity factor

Figure 3.2: Conductivity meter(TDS meter)

3.3.4 pH

To determine the pH of water sample pH meter is used.

- **Calibration:** Calibration is necessary to ensure precision in measurements. The majority of pH meters need to undergo a two-point calibration with two buffer solutions. Clean the electrode with distilled water before submerging it in the pH 7.00 buffer solution. Wait until the reading is steady, then calibrate the meter to match this value as per the manufacturer's guidelines. Clean the electrode once more with distilled water, then submerge it in either the pH 4.00 or pH 10.00 buffer solution (based on the anticipated pH range of your sample). Set the meter to the appropriate value. It is suggested to use a three-point calibration (using pH 4.00, 7.00, and 10.00 buffers) for increased accuracy.

- **Sample Measurement:**

Wash the electrode with distilled water and pat it dry using tissue or paper that is free of lint.

Dip the electrode in the water sample. Ensure the electrode is fully submerged and there are no air bubbles around it.

Wait for the reading to get stable This may take some seconds.

3.3.5 Total Alkalinity

Determining the total alkalinity of a water sample via titration involves measuring the ability of water to balance out acids. This usually happens because bicarbonates, carbonates, and hydroxides are present.

Preparation:

Collect the water sample in a clean container.

Fill the burette with the standard HCl solution. Note the initial volume.

- **Phenolphthalein Alkalinity:**

Pipette 50 mL of the water sample into a conical flask.

Add 2-3 drops of phenolphthalein indicator. If the solution remains same colorless, it indicates that there is no hydroxide or carbonate alkalinity, and you can skip to the next step.

If the solution changes its color to pink, titrate with the HCl solution until the pink color just disappears. This is the phenolphthalein endpoint.

Record the volume of HCl used (V1)

- **Total Alkalinity:**

To the same sample (whether it turned colorless after the phenolphthalein step or not), add 2-3 drops of methyl orange indicator. The solution will change its color to yellow.

Continue titrating with the HCl solution until the color changes from yellow to a reddish orange, indicating the methyl orange endpoint.

Record the total volume of HCl used (V2).

Figure 3.3: Alkalinity Test

3.3.6 Sulphate Test

Testing for sulfate in a water sample using a turbidimeter involves creating a turbidity reaction with the sulfate ions and measuring the resulting turbidity.

- **Preparation:**

Turn on the turbidimeter and allow it to warm up according to the manufacturer's instructions.

Prepare the calibration curve using standard sulfate solutions with known concentrations.

- **Calibration:**

Prepare a series of sulfate standards (e.g., 0, 10, 20, 50, 100 mg/L) by diluting a standard sulfate solution with distilled water in volumetric flasks.

Add a specific volume of barium chloride reagent to each standard solution to precipitate the sulfate ions as barium sulfate ($BaSO_4$), which forms a suspension.

Mix each solution thoroughly and allow it to stand for a specific time to develop turbidity. Measure the turbidity of each standard solution with the turbidimeter and record the readings.

- **Sample Preparation:**

Filter the water sample if it is turbid or contains particulate matter to avoid interference.

Measure a specific volume of the water sample (e.g., 50 mL) and transfer it to a clean container.

- **Measurement:**

Measure the turbidity of the reacted water sample using the turbidimeter.

Record the turbidity reading.

- **Determination:**

Utilize the calibration curve to establish the sulfate concentration in the water sample by taking into account the detected turbidity.

3.3.7 Nitrate Test

Testing for nitrate in a water sample sulfanilamide and N-(1-naphthyl)-ethylenediamine dihydrochloride.then colored compound, that is able to be quantified using spectrophotometry.

- **Sample Preparation:**

Filter the water sample if it contains particulate matter to avoid interference.

Measure a specific volume of the water sample (e.g., 10 mL) and transfer it to a clean test tube or reaction vessel.

- **Preparation of Reagents:**

Nitrate Reagent Solution: Typically, a mixture of sulfanilamide and N-(1-naphthyl)-ethylenediamine dihydrochloride. These reagents are often provided in commercial test kits.

Color Developing Solution: Usually provided in commercial kits, which reacts with nitrates to form a colored compound.

- **Addition of Reagents:**

Add a specified amount of the nitrate reagent solution to the water sample.

Mix thoroughly to ensure the reagent is fully dissolved in the sample.

- **Color Development:**

Allow the sample to stand for a set period (typically 10 minutes) for the color to develop.

The nitrate in the sample reacts with the reagent to form a reddish-pink color, the intensity of which is proportional to the nitrate concentration.

- **Measurement:**

Set the spectrophotometer to the appropriate wavelength .Measure the absorbance of each standard solution and make a graph showing absorbance plotted against nitrate concentration to calibrate.

3.4.8 Free Residual Chlorine Test

Testing for free residual chlorine in water by the visual comparison method involves using a colorimetric reagent that shows reaction with chlorine to produce a color change. The resulting color is then compared to a color standard to determine the chlorine concentration.

- **Sample Collection:**

Rinse the test tube or sample cell with the water sample to remove any contaminants.

Fill the test tube with a measured amount of the water sample, usually indicated on the comparator kit instructions.

- **Reagent Addition:**

Add one DPD reagent tablet or the specified number of drops of DPD solution to the test tube.

Close the lid of test tube and shake it gently to dissolve the tablet or mix the solution thoroughly. The sample will turn pink if free chlorine is present.

- **Color Development:**

Allow the color to develop for the time specified by the reagent manufacturer, usually around 1 minute.

- **Comparison:**

Place the test tube with the developed color into the comparator kit next to the color standards.

Hold the comparator up to a light source, such as natural daylight, to accurately compare the color of the sample with the color standards.

Match the color of the sample with the closest color standard to determine the free chlorine concentration.

- **Recording Results:**

  Note the corresponding free chlorine concentration from the color standard that matches the sample.

3.3.9 Conductivity test

Conductivity testing using the electrometric method involves measuring the ability of water to conduct an electric current, which is directly related to the concentration of dissolved ions.

- **Calibration:**

  Adjust the conductivity meter using standard solutions of known conductivity levels.

- **Sample Measurement:**

  Rinse the conductivity probe with distilled water to remove any residual calibration solution.

  Collect the water sample in a clean beaker.

  Immerse the conductivity probe in the water sample. Ensure the probe is fully submerged and that there are no air bubbles around the electrode.

  Wait for the reading to stabilize. This may take some seconds

Figure: 3.4: Conductivity meter

3.3.10 Chloride Test

Testing for chloride using the argentometric method, also known as the Mohr method, involves titrating chloride ions with silver nitrate ($AgNO_3$) to form silver chloride (AgCl), which precipitates out of solution.

- **Sample Collection:**

Collect the water sample in a clean jar.

Measure a specific volume of the water sample (e.g., 50 mL) using a pipette and transfer it to an Erlenmeyer flask or titration vessel.

- **Indicator Addition:**

Add a few drops (typically 1-2 mL) of potassium chromate indicator solution in the water sample in the flask. The solution should turn a light yellow color, indicates the presence of chloride ions.

- **Titration:**

Place the flask on a white tile to better observe the color change.

Begin titrating by slowly adding the silver nitrate solution from the burette into the water sample while swirling the flask continuously.

The silver ions (Ag^+) react with chloride ions (Cl^-) in the sample to form silver chloride ($AgCl$), which precipitates out of solution.

Continue adding silver nitrate solution until a persistent reddish-brown color appears, indicating the formation of silver chromate (Ag_2CrO_4) due to the excess of silver ions reacting with the chromate ions from the indicator.

- **Endpoint Determination:**

The endpoint is reached when the yellow color of the potassium chromate indicator changes to a persistent reddish-brown color. This color change signifies that all chloride ions in the sample have reacted with the silver ions.

Note the volume of silver nitrate solution used from the burette to reach the endpoint.

Figure 3.5: Chloride Test

CHAPTER - 4

RESULTS AND DISCUSSION

4.1 Construction

The construction of the rapid sand filter water treatment plant has made significant progress since its initiation. Following stages of construction of WTP has been completed so far

- Project Planning and Design
- Site Preparation
- Foundation Construction
- Structural Construction
- Piping and Instrumentation
- Reinforcement
- Concreting

Figure 4.1: Leveling of site

Figure 4.2 : Site Preparation

Figure 4.3: Laying of pipes

Figure 4.4: Foundation Preparation

Figure 4.5: Framework

Figure 4.6: Pipe Installation

Final water compliance:

4.2 pH

The pH value indicates the acidity or alkalinity level of a specific solution. It is noted that the pH levels are higher in January and February compared to other months because of the colder temperatures, as the correlation between pH and temperature indicates that lower temperatures result in a decrease in H+ ion concentration, leading to an increase in pH levels. The pH of the untreated water was generally higher than that of the treated water, possibly due to the use of chemicals like chlorine, alum, and lime in the water treatment process leading to a slight pH reduction. Primarily, no unacceptable outcomes were discovered.

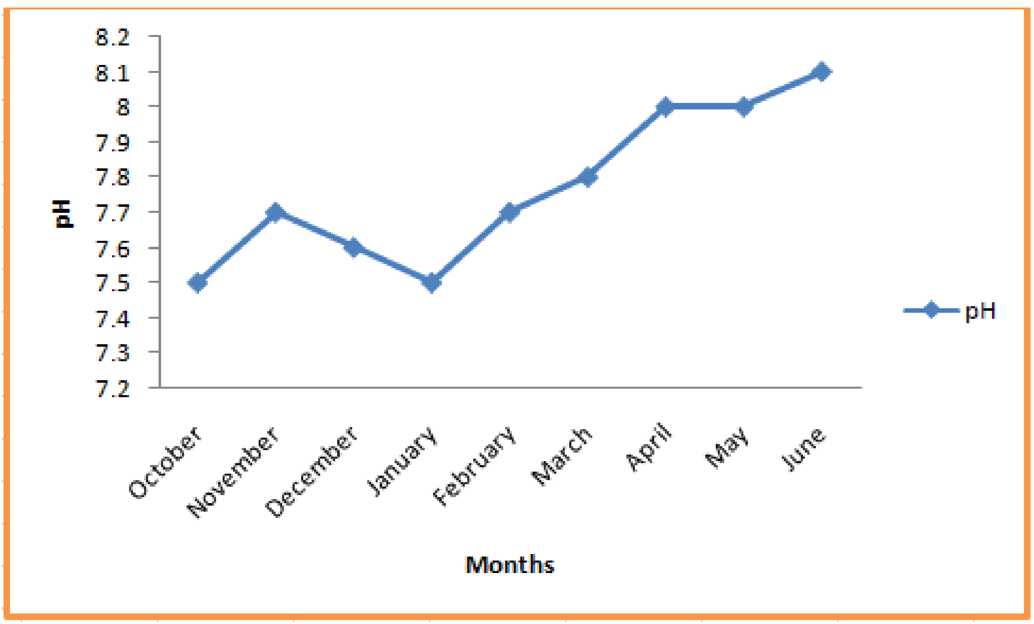


Figure 4.7: Analysis of pH over the months

4.3 Conductivity

Pure water is not a good conductor of electric current and instead acts as a strong insulator. An increase in the concentration of ions results in an increase in the electrical conductivity of water. EC could serve as a useful sign of pollutants in surface water. According to WHO guidelines, the electrical conductivity value should not exceed 0.4 ms/cm. During the colder months, the low water temperature often results in a decrease in water conductivity. Cold water has a lower concentration of dissolved ions, resulting in lower conductivity compared to warm water. Runoff and precipitation also enhance the conductivity of water bodies. It is noted that the conductivity is lower in January and February compared to other months because of the water temperature's influence on conductivity. Additionally, there is a spike in conductivity in April which is attributed to increased rainfall.

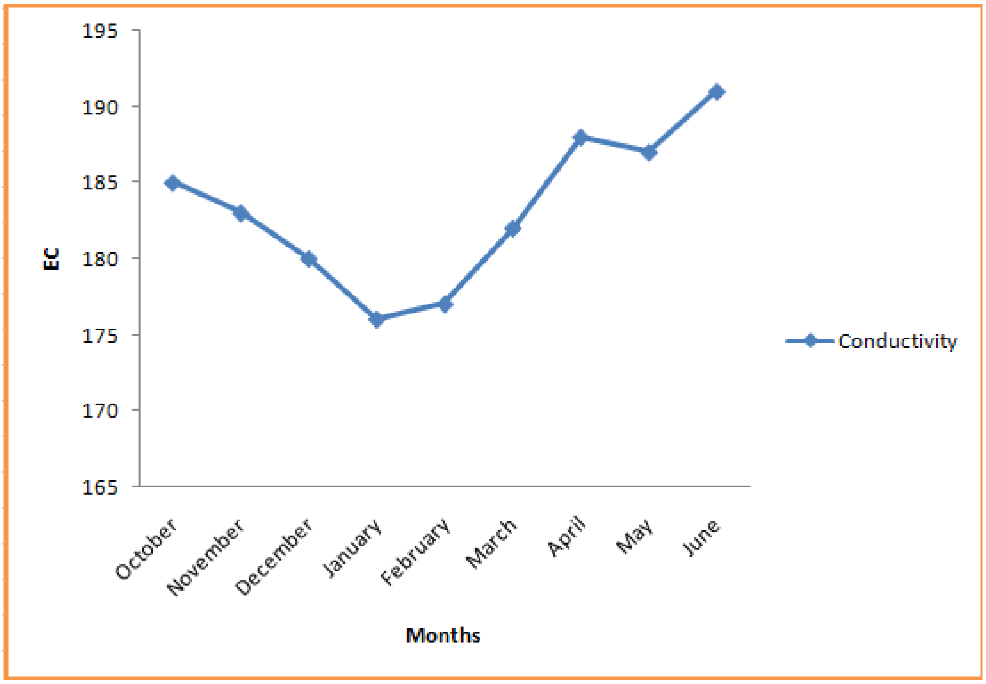


Figure 4.8: Analysis of Conductivity

4.4 Total Alkalinity

Measuring alkalinity determines how well water bodies can maintain a stable pH level by showing their capacity to resist pH changes. Various natural and man-made factors, such as geological composition, seasonal fluctuations, biological activity, human actions, and natural occurrences, affect the overall alkalinity of water. Regions experiencing rapid erosion may exhibit elevated levels of alkalinity. Temperature changes once more affect the performance of the TA. There was no significant seasonal impact on the water alkalinity. It fell within the acceptable range. Aquatic plants and algae perform photosynthesis in the daylight, absorbing carbon dioxide which could lead to a rise in pH and a decrease in bicarbonates. At night, breathing produces carbon dioxide, which can react with water to create bicarbonates and raise alkalinity. Chemical substances like lime or sodium bicarbonate, which are included in water treatment procedures, have the ability to raise alkalinity levels. Fertilizers and lime in agriculture can raise alkalinity in water bodies when they wash off.

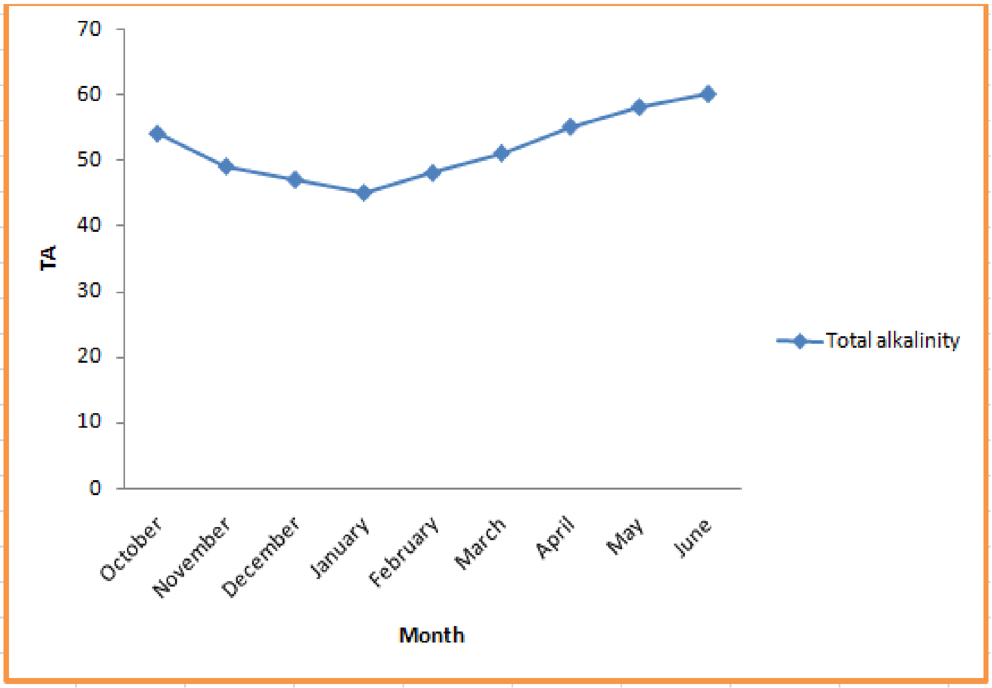


Figure 4.9: Total alkalinity analysis

4.5 Total Hardness

The overall hardness of water is determined by the levels of calcium and magnesium ions that are dissolved in the water. The duration water is in contact with mineral-rich substrates and the route it takes through mineral deposits can impact the levels of hardness. Intense rainfall or melted snow can reduce hardness by introducing soft water with low mineral content. On the other hand, in periods of low rainfall, minerals can be concentrated through evaporation, leading to higher levels of hardness. During the colder months, hardness levels increase, while they decrease during moderate weather conditions. January has experienced a significant rise in overall hardness levels.

Figure 4.10: Analysis of Total hardness

4.6 Turbidity

Considering turbidity is a crucial aspect in assessing drinking water quality. While turbidity may not immediately endanger public health, it is worth noting that suspended particles causing turbidity in surface water samples can facilitate the presence of metal ions, microbial pathogens, etc. A significant decrease in turbidity was observed in January and February, indicating that freezing temperatures and precipitation were the contributing factors. Heavy rainfall and snow can lead to higher turbidity levels, whereas dry periods may result in lower turbidity due to less runoff and sediment entering the water.

Figure 4.11 Analysis of Turbidity

4.7 Total dissolved Solids

Water flowing through certain types of rocks and soil can dissolve minerals, leading to higher TDS levels. For instance, when water passes through limestone, it could contain increased amounts of calcium carbonate. Groundwater generally has elevated TDS concentrations in contrast to surface water due to increased exposure to rocks and soil. The breakdown of plants and animals introduces organic and inorganic compounds into the water, impacting total dissolved solids (TDS). Variations in temperature and precipitation can impact the levels of dissolved solids in bodies of water. A significant variation was observed in the months of January, February, October, and May due to changes in rainfall, runoff, and TDS levels.

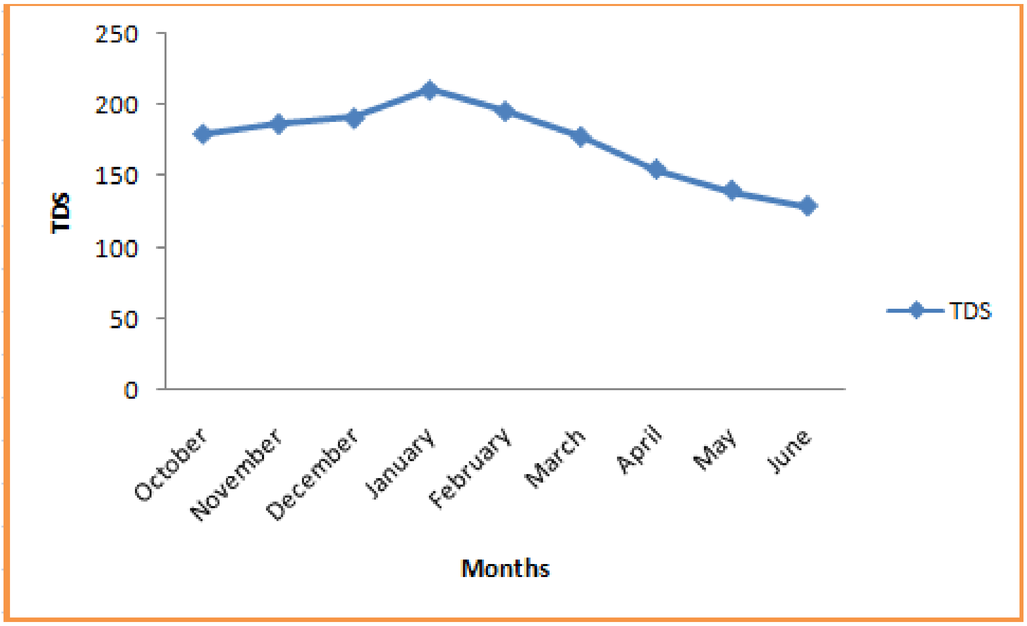


Figure 4.12: Analysis of TDS

4.8 Chloride

Most of the chloride levels are man-made, showing that they come from activities carried out by humans. Keeping track of chloride levels is crucial in evaluating water quality, as elevated concentrations of chloride can harm aquatic life, infrastructure, and human health. Changes in the speed and quantity of water in rivers and streams can impact chloride levels, as increased flow usually results in lower concentration levels. Using salt (sodium chloride) to deice roads in winter can result in a substantial amount of chloride being washed into surrounding water sources. Fertilizers and methods of watering can bring chlorides into water by runoff and leaching. Variations in rainfall, temperature, and sea levels can impact the levels of chloride in water. Once again, the chloride content has increased in January, which is the coldest month of the year. During the winter season, there is typically a decrease in rainfall, resulting in lower levels of chlorides in water bodies due to reduced dilution. Snow buildup does not reduce chloride levels until it thaws.

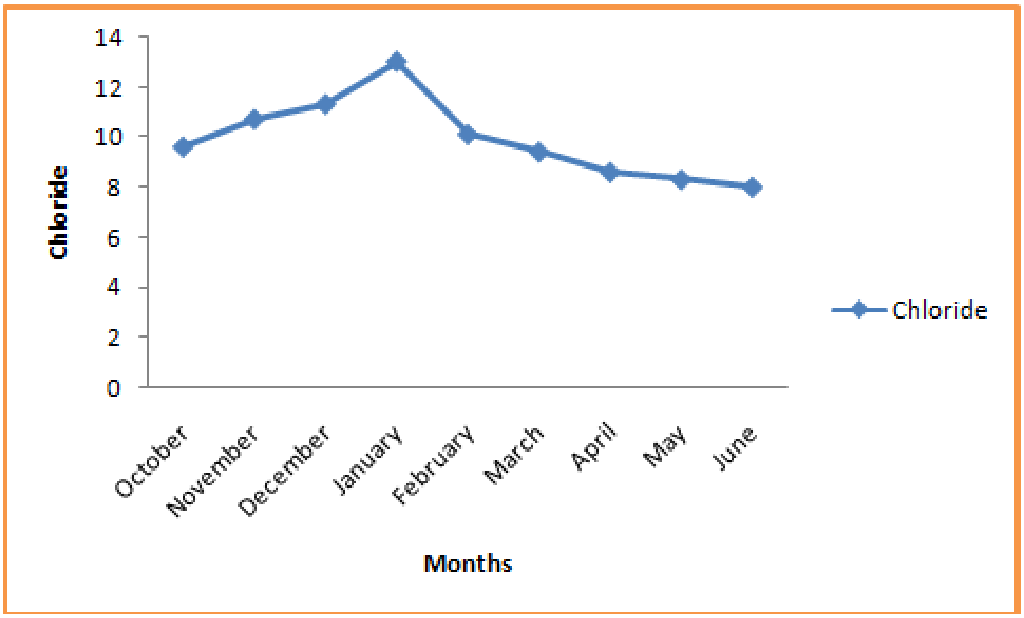


Figure 4.13: Analysis of Chloride Content

4.9 Free Residual Chlorine

Free residual chlorine in water, which refers to the concentration of chlorine remaining after the initial disinfection process Factors such as multiple elements can impact the amount of chlorine left in water following the disinfection stage, known as free residual chlorine. Increased amounts of bacteria and other microorganisms use up additional chlorine, resulting in decreased leftover levels. The initial chlorine quantity added impacts the residual level; too little dosing could lead to low residual chlorine. Elevated temperatures may speed up the rate at which chlorine reacts with other substances, possibly decreasing the amount of residual levels. On the other hand, extremely cold temperatures can cause a deceleration in these reactions, which could result in elevated levels of remaining substances. A clear distinction was noticed between the different seasons.

Figure 4.14: Analysis of free residual Chlorine

CHAPTER - 5

CONCLUSION

The River Sindh's water quality is impacted by both natural and human activities. The water treatment plant plays a crucial role in mitigating these impacts, ensuring the avaliablity of safe and high-quality water to the community. Continued monitoring and adaptive management strategies are essential to address seasonal variations and potential sources of contamination. Enhancing infrastructure, adopting sustainable agricultural practices, and improving runoff management will further contribute to the longer sustainability of water qualities in the region. The TDS levels in the River Sindh are influenced by the geological characteristics of the watershed, including mineral content and soil composition. Seasonal variations, particularly during monsoon and winter, also affect TDS levels due to runoff and decreased dilution. The treatment plant has demonstrated effectiveness in reducing TDS to acceptable levels, ensuring the water is suitable for consumption and other uses. Chloride levels in the River Sindh are subject to fluctuations based on natural processes and anthropogenic activities. The use of road salt during winter and agricultural runoff are significant contributors to elevated chloride levels. Also The treatment plant has successfully maintained appropriate residual chlorine levels, ensuring microbial safety while minimizing potential health risks associated with chlorine by-products. The new 5 MGD plant will significantly increase the capacity to treat water, accommodating the growing needs of the local population and reducing the risk of water unavailability during peak demand periods. State-of-the-art infrastructure and equipment will improve the efficiency and reliability of water treatment processes, ensuring consistent delivery of high-quality water. Rapid sand filtration (RSF) plant will yield significant outcomes, markedly improving water quality and public health. The RSF plant effectively will remove suspended solids, turbidity, and pathogens, delivering clear and safe drinking water. This enhances the community's overall well-being by reducing waterborne diseases and supporting healthy lifestyles. The plant's high throughput and ease of operation ensure it can meet the growing water demand of Srinagar city efficiently. The project faced delays due to logistical issues, and environmental factors. Effective project management and securing additional resources were crucial in mitigating these delays and keeping the project on track. Ensuring the plant's long-term success requires regular maintenance, periodic upgrades, and continuous monitoring to adapt to changing water quality and demand. Training and capacity building for plant operators and staff will be essential to maintain high operational standards and leverage new technologies effectively.

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