Synopsis on

INTEGRATED URBAN WATER MANAGEMENT SYSTEM FOR CHANDIGARH

Submitted for registration in the degree of

Doctor of Philosophy

Submitted by

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1.0 INTRODUCTION TO INTEGRATED URBAN WATER MANAGEMENT IN INDIA

Beside the environmental change conjecture, another factor influencing future security of urban water supply is the expansion in water request attributable to development in population, thriving and ensuing urban improvement. Indian urban communities are confronting issues identified with water accessibility, quality and administration. As a rule, the arranging and execution of water utilize is attempted in storehouses with practically no association between and crosswise over areas. This prompts visit water shortage and water contamination. Around 30% of individuals in India live in urban areas that are required to two fold in population by 2050. With a developing economy and changing ways of life the weight on officially stressed water assets is expanding. The legislature has demonstrated an enthusiasm for Integrated Urban Water Management (IUWM) as another structure and approach for the country [39].

1.1 NEED FOR INTEGRATED WATER MANAGEMENT SYSTEM

Urban water and wastewater structures should without harming the earth give clean water to a variety of occupations, remove wastewater from customers to backwoods every unhygienic condition, and empty tempest water to keep up a key separation from hurt from flooding. Most urban communities in India are water worried, with no city having all day, every day water supplies. As indicated by the Ministry of Urban Development (MoUD), 182 urban areas require quick consideration concerning legitimate water and wastewater administration. As per official measurements, the scope of sanitation has expanded however asset manageability and slippages are exceptionally basic in that scope.

In addition, in urban areas with in excess of one million individuals, the official water supply after 35% misfortune in spillages is only 125 liters/day for each capita which is extensively lower than the request of 210 liters/day for every capita. Framework advancement and controls have not kept pace with populace development and urbanization and therefore wastewater administration has turned into a noteworthy test. Government has attempted huge endeavors to lessen surface water contamination yet they remain risked by the absence of wastewater treatment. An expected 160 million restrooms and septic tanks add to 80% of the contamination of the national surface waters [37].

There is additionally major groundwater abuse in urban India the same number of towns and urban areas rely upon groundwater for their supply. Change is required which decreases non-income water, groundwater abuse, thinks about waste as an asset, and takes a gander at the water cycle comprehensively. Every individual has a benefit to clean water. For urban zones, our vision is water organization where water and its constituents can be safely used, reused and returned to nature.

1.2 POTENTIAL SOLUTION FOR INDIA

The IUWM approach is a paradigm shift for urban water management. It's anything but a prescriptive model however a procedure that welcomes existing urban areas and rising ones to alter their present arranging and administration hones, given their own needs, in a hydrological, ecological and financial setting. It depends on the accompanying key ideas:

• Participation of key partners originating from people in general, private and social divisions speaking to various financial exercises that have an enthusiasm for water in urban regions. There can be numerous partners included yet an understanding should be come to with the agents of nearby government who remain the principle convener. Not all have a similar part and obligation, but rather all should know and contribute. The investment of partners is required keeping in mind the end goal to: break 'storehouses' between various segments and exercises; achieve a typical comprehension and vision of difficulties and exercises; comprehend and adjust premiums and necessities of various partners; fortify collaboration, manageability and possession; and instigate conduct change and practical request administration.

• Urban water security through a comprehensive approach suggests overseeing water assets and its loss in another coordinated path, with an emphasis on: considering the entire urban water cycle as one framework inside the watershed; going for water security through decent variety and ideal utilization of every potential wellspring of water and coordinating water quality with reason for utilize; going for a superior use of regular frameworks for water and wastewater treatment; considering storm water/water catchment frameworks as a potential source; better overseeing utilization of water, effluents and water request and cleanliness conduct; fortifying spillage administration and support; reinforcing strength of urban water frameworks that are confronting dry season or surges.

• Wastewater is an asset that can be utilized beneficially. Dim water can be reused for water system, urban horticulture and mechanical procedures, treated or untreated relying upon the reason for its utilization and its enactment; supplements in wastewater (dim and dark) can be utilized for vitality creation and compost generation.

• Optimum framework configuration suggests the accompanying key focuses: innovation determination for water supply, wastewater treatment and sanitation depends on a multi-criteria choice emotionally supportive network to investigate an extensive variety of markers; such pointers incorporate water quality, monetary state of family units, size of populace, access to cutting edge advancements and gifted labor, accessibility of land, institutional set up and then some; and this incorporates green foundation and minimal effort and vitality proficient choices, regular frameworks and inventive advances.

Compelling water administration with an IUWM view point incorporates numerous angles with the primary after key components: receiving another outlook, a comprehensive and cross sectoral approach connecting urban water administration with general urban arranging; modifying a portion of the arrangement and enactment concerning the utilization of water and reuse of waste water; breaking down parts of concentrated and decentralized administration; evaluating the monetary and budgetary effect of embracing an IUWM approach; fabricating the limit of specialized and administrative staff; and offering data to people in general and clients [9].Therefore, there are vulnerabilities about the appropriateness of the outline of existing tempest water collecting frameworks and how these frameworks perform in connection to the administrator destinations. Only one prominent instance of general wellbeing or ecological disappointment of a tempest water-reusing venture could undermine open trust in this elective supply choice and make a huge hindrance to its far reaching selection.

There is a need to precisely compose which are the most basic criteria for a prudent change as to urban water organization. Finally, a need once-over of eight valuable reasonability criteria/markers is proposed [40].

The specific endeavors deal in a general sense with: (1) drinking water—treatment and flow; (2) storm water organization; and (3) wastewater and sludge—recovery of things. The planned assignments focus on: (1) social-saving points, (2) sterile perspectives, (3) risk examination and correspondence advances, and (4) usage of things from the urban water system.

A system structure should be examined for drinking water, storm water, and wastewater creation/transportation/treatment, assets required and things conveyed in these methods. It may be either a present sort of system or a theoretical new structure. The crucial system structures that are to be inspected inside this examination program can be segregated along three tomahawks (suitable to drinking water, storm water, and sterile wastewater): level of centralization, level of source partition, and system scale. It should be seen that the model urban groups and the system structures are estimated assembling pieces described with the objective that they may be exchanged and recombined in any demand. This approach will allow a broad assortment of different total system portrayals to be analyzed, i.e., a couple of sorts of model urban groups may be united to shape one heterogeneous city with a couple of various system structures for its water and wastewater administration.

1.3 STORM WATER HARVESTING SYSTEM

A storm water harvesting system, depending on the uses it has been established for, includes the following structural components:

1. A gathering framework to reap storm water, which incorporates a customary waste system, for example, canals as well as funnels; channels; or water touchy urban outline storm water courses, for example, vegetated earthen swale depletes or filter channels.
2. A treatment system to impact the accumulated water to fit for the normal uses. This fragment could fuse no less than one treatment trains-water touchy urban outline compose treatment offices, for instance, lakes, wetlands, swales; storm water bio-channels; physio-substance treatment; and post-treatment filtration.
3. A capacity framework to store water and give additional water treatment through sedimentation of particles. It could incorporate secured tanks or is uncovered limit, for instance, an open lake. The arranged furthest reaches of capacity framework is commonly a trade off between boosting volumetric relentless quality and restricting the required stockpiling size and related land and advancement costs.
4. A dissemination framework to circle treated tempest water by methods for open space water framework structure or twofold reticulation system. The assurance of the sort of assignment structure is dependent on the end-use, spatial size of movement and thickness of end-uses (single or various) [29].

1.4 FLOOD RISKS IN URBAN AREAS

On a very basic level chance is seen remotely by contrasting it and the occasion of an exceptional event or danger (surge, dry season, shudder, tempest, torrential slide etc.) caused by trademark powers or by a mix of typical forces and human effects. Regardless it is vital to consider the second portion in the development of risk is the way that some individual or something must be in threat; i.e. feeble against a hazard. "Peril is the probability of an adversity, and this depends upon three segments: risk, shortcoming, and introduction. In case any of these three segments in peril augmentations or diminishments, by then the risk additions or decreases separately." [25]

Hazard = Task (Threat x Exhibition x susceptibility)

1.5 INTEGRATED MANAGEMENT OF URBAN FLOODS

Last target of any organized urban surge chance organization is to confine human disaster and financial damages, while making use of the ordinary resources for the favorable position and success of the overall public. In any case it is recognized surge risks can't be inside and out dodged, in this manner they should be administered. This may be proficient either by decreasing surge threats to a sufficient level or by holding, sharing or trading surge risks through individual measures. This can be refined by appropriate appreciation of

i. risk examination,

ii. masterminding and use of measures,

iii. evaluation and danger reassessment.

1.6 PLANNING AND IMPLEMENTATION OF MEASURES

Arranging and usage incorporates Preparedness; Response; and Recovery. Readiness measures endeavor to anticipate potential dangers transforming into disasters. Reaction measures are actualized during or straight forwardly after a flooding rate. Preventive and preliminary measures are by and large more cost-proficient and practical than crisis reaction measures. Recuperation plan to the authoritative recreation of harmed framework [27].

2.0 STUDY AREA CHANDIGARH

2.1 WATER AVAILABILITY, USAGE AND CONSERVATION IN CHANDIGARH

Figure 2.1 : Study Area Chandigarh [36]

The present water supply service area of Municipal Corporations Chandigarh (MCC) is 114 km^2, which includes MCC area 79.34 km^2 and rural area of 34.69 km^2. The urban area falls in jurisdiction of Municipal Corporation and the water supply system is entrusted to Public Health wing of MCC. The transmission mains carry raw water from Kajauli to the water treatment plants located at Sector 39, Chandigarh. At Sector 39, the water is treated, disinfected and transmitted to 7 No. subsidiary water works located in sectors 12, 26, 32, 37, 52 and Manimajra [36].

The average availability of water in Chandigarh is reasonably high at 332 Litres per Capita per Day (LPCD), stands second in the country after Goa (343 LPCD). Chandigarh gets 14.5million gallons per day (MGD) water as its share from each phase of Kajauli water supply scheme.

Chandigarh is a highly urbanized city and the rooftop of the buildings can be suitably used for artificial recharge of the rainfall falling in Chandigarh. There is lot of green area too and some water bodies that can also be effectively utilized for recharging the rainfall runoff. In Chandigarh, there are two distinct aquifer systems - shallow and deep. Shallow aquifer occurs under semi-confined conditions and exists down to 20 to 30 m below land surface. Deep aquifers below 40 m are under confined conditions [36].

Central Ground Water Board, North-Western Region has provided technical assistance to innumerable organizations and individuals regarding artificial recharge and rainwater harvesting in Chandigarh. Some of these are:

1. ISBT, Chandigarh, The Executive Engineer, Project PH Division No. 1, Chandigarh.
2. GPRA quarters, Sector 7, The Executive Engineer, CPWD Division- 2,CPWD, Chandigarh.
3. Ryan International School, Sector 49-B, Chandigarh (U.T.)
4. Judicial Academy, Sector-43, Chandigarh. Executive engineer, PH Division 7, sector-11
5. Petrol Pump sector-41, Bharat Petroleum Corporation Ltd., Sector 19-B, Madhya Marg, Chandigarh
6. Indian Oil Petrol Pump, Sector 28-C, Chandigarh.
7. National Bank For Agriculture and Rural Development, Plot No. 3, Sector-34-A
8. A.G. Punjab Building, The Assistant Engineer, CPWD, Division VIII,
9. DLF Complex, IT Park, Kishangarh, Chandigarh.
10. BBMB complex, Sector 19, Chandigarh

11. Plot No. 4 and 5 for the existing building of A.G. Haryana, Sector 33-B, Chandigarh (U.T.). Chandigarh Central Sub Division No. 10, Central Public Works Department
12. Geological survey of India, Sector 33-B Chandigarh Central Sub Division No. 10,Central Public Works Department
13. Air force station, Sector 31 and Sector 47 for Married Accommodation Project (MAP).The Chief Engineer, HQ, CE Chandigarh Zone, 'N' Area, Airport Road, Chandigarh - 160 003.
14. G.G.D.S.D. College, Sector 32, Chandigarh.
15. Industrial Training Institute, Sector 28, Chandigarh.
16. Kendriya sadan, Sector 9, The Executive Engineer, CPWD Division, Chandigarh.
17. Government Central Grafts Institute for Women, Chandigarh.
18. PCDA Building complex at Sector 9, Chadigarh.
19. Various Building of Judicial complexes and Residence of Hon’ble Chief Justice and other Hon’ble Judges of Punjab and Haryana high court.
20. Family quarters at CRPF campus Hallomajra.
21. SBI Building at Sector 17, Chandigarh.

The ground water resource of shallow aquifer in Chandigarh as follows: -

a. Recharge from rainfall during monsoon = 1545 ham
b. Recharge from other source during monsoon = 62 ham
c. Recharge from rainfall during non-monsoon = 488 ham
d. Recharge from other sources during non-monsoon = 61 ham
e. Total annual ground water recharge = 2156 ham
f. Natural discharge during non-monsoon = 216 ham
g. Ground Water Draft as on 31.03.2011 = nil
h. Net annual ground water availability = 1940 ham

Based on the data generated from the analysis of ground water samples drawn from hand pump and tube wells, it is found that the ground water is fresh and suitable for drinking as well as irrigation purposes. Normally, the ground water drawn from the deeper aquifers is less mineralized as compared to water drawn from shallow aquifers [36].

2.2 TOTAL WATER AVAILABILITY AND THE POSSIBLE PROJECTION OF ITS DEMAND IN NEAR FUTURE

As per Bureau of Indian Standards (BIS) code 1172-1993 the per capita water prerequisite for the urban areas with homes more than 100,000 with full flushing frameworks require 150-200 Liters for each day. This may boil down to 135 Liters for each capita for Economically Weaker area of the general public. In this specific situation, Chandigarh is giving more water per capita than required. Water request in light of the flow populace (statistics 2011) is around 426.50 MLD. This incorporates 158.25 MLD for local utilization, 29.09 MLD for plugs/mechanical request, 46.15 MLD for group/institutional request, 20.07 MLD for stand post restroom squares and wastage of water almost 15% stands at 38.04 MLD. What's more agricultural water request is 134.90 MLD [39].

2.3 WATER CONSERVATION PRACTICES IN CHANDIGARH

Water preservation implies protecting our water assets from contamination and being squandered. It is imperative since plants, people and creatures all need water to survive. Without water, the earth would have no life. Because of reliable water assets, however expanding population and request of water; the city wonderful has likewise been rehearsing water protection by following diverse preservation methodologies.

Rain Water Harvesting: Rainwater harvesting (RWH) for revive enlargement is among the real exercises being taken by the Central Ground Water Board for the viable execution of decisive plans. With the exponentially expanding interest of water assets because of heightening populace, the city wonderful "Chandigarh", has likewise ensnared the plan at the exceptional speed in a limited ability to focus time. The water reaping capability of Chandigarh, with a region of 114 km^2 and the normal yearly precipitation of 1059.3, is figured to be 60380.1million liters or 13241 gallons or 36.28 MGD. In this manner, the potential is more than the water drew out of aquifers and along these lines, effective harvesting of water and legitimate energizing of groundwater will go far in contributing towards manageability of water supply.

2.4 DRAINAGE SYSTEM IN CHANDIGARH

There are separate sewer and storm water drainage systems in Chandigarh. The sewerage and storm water is discharged by gravity flow due to good natural slope from north east to south west. The slope also helps the sewers to be naturally cleaned due to the good self cleansing velocities.

Table 2.1: Drainage System (2007-2016)

MW Drainag System					
Year	**Sectors With Planned Drainage System**	**Sectors With Not Planned Drainage System**	**Sectors With Originally Planned Drainage System**	**Sectors With Modified Planned Drainage System**	**Length of Storm Water Drainage (KM)**
2007	1 To 56 Sectors	-	1 To 56 Sectors	-	-
2008	1 To 56 Sectors	-	1 To 56 Sectors	-	-
2009	1 To 56 Sectors	-	1 To 56 Sectors	-	713
2010	1 To 56 Sectors	-	1 To 56 Sectors	-	-
2011	1 To 56 Sectors	-	1 To 56 Sectors	-	715 Approx.
2012	1 To 56 Sectors, 61 & 63 Sector	-	1 To 56 Sectors	1 To 56 Sectors	720
2013	1 To 56 Sectors, 61 & 63 Sector	-	1 To 56 Sectors	1 To 56 Sectors	722
2014	1 To 56 Sectors, 61 & 63 Sector	-	1 To 56 Sectors	1 To 56 Sectors	1030
2015	1 To 56 Sectors, 61 & 63 Sector	-	1 To 56 Sectors	1 To 56 Sectors	1030
2016	1 To 56 Sectors, 61 & 63 Sector	-	1 To 56 Sectors	1 To 56 Sectors	1050
2017	Pending….	-	-	-	-

Source: Executive Engineer ,MCPH, Div.4,Chandigarh, Executive Engineer, MCPH, Div.No.1,Chandigarh [39]

2.5 Area wise Stormwater

Chandigarh has an aggregate rain water collecting limit of over 70% of the aggregate land region. The aggregate limit of water that would be accessible for energize every year is:

58 sq. km (area) x 1059.3 (rainfall) x 0.5 (rainfall coefficient) = 30,720 million litres [39].

Table 2.2: Area wise Stormwater (2016)

Area	Storm Water
From Roads	15.89 sq. km
From the Rooftop of Residential area	30.19 sq. km
From Public and Institutional Buildings	7.94 sq. km
From Shopping area	3.97 sq. km

To diminish reliance on ground water a transient lawful structure has been laid by the Administration to make arrangements for water gathering required while conceding the extra secured region to all plots over 500 m^2 zones.

2.6 Recycle and Reuse of treated waste water:

Chandigarh is completely secured with sewerage office and furnished with the 100% sewerage treatment facility. Out of 87 MGD water being provided to the occupants of the city, 57 MGD sewage effluent is being created every day. Out of which, normal 53.85 MGD waste water is treated consistently.

Perceiving the significance of water, Chandigarh had, prior in 1991, started tertiary treatment of wastewater at Diggian STP (10 MGD) and later provided it for the non-consumable uses, for example, water system of greenery enclosures, green belts and yards, washing autos and so forth., to various divisions. Directly, the introduced limit with respect to tertiary treatment is 20 MGD at Diggian STP which is treating 10 MGD water (avg.), nonetheless, the present request of tertiary treated water is 6 MGD. According to new local laws the utilization of tertiary treated water has been made compulsory for all houses having region of 1 channel or more. At present, tertiary treated water is accessible for use in division 1, 4, 5, 6, 7, 9, 12, 15, 16, 18, 19, 20, 21 and 61; while segments 2, 3, 8, 10, 11, 14, 17, 23, 25, 33, 34, 37, 41 and 42 are given the fractional accessibility of the same[39].

Table 2.3: Area Details

City Parameters	City Data
Municipal population	10.54 lacs
Volume of Domestic & Industrial waste water generated	57 MGD(approx)
Treated waste water	53.85 MGD
No. of STPs	5
Capacity of each STP	16 MGD – 3BRD
	5 MGD – Raipur Kalan
	30 MGD – Diggian
	1.25 MGD – Raipur Khurd
	1.6 MGD –Dhanas
	Total: 53.85 MGD
Proposed STPs	1.7 MGD at Khuda-ali-sher
	15 MGD is under renovation Diggian, Mohali
	Total: 16.7 MGD
Mode of disposal	Natural choe for all except Diggian. Diggian STP effluent goes to Irrigation Channel

Source: CPCC, Chandigarh [39]

2.7 WATER QUALITY ANALYSIS OF DRAINS/ STP

Water quality examination of the considerable number of channels and sewage treatment plants set up in the U.T. area are completed frequently (month to month premise) to watch out for the nature of water moving through the city. But the open channels (SukhnaChoe, Patiala Ki Rao, North Choe) going through the city, the treated water of STP's lies close to as far as possible. According to the new rules upgradation of all STP's is proposed to take the BOD of treated water underneath the figure of 10 mg/L.

Like the abutting conditions of the city, no groundwater from shallow tube wells in Chandigarh is endorsed as drinkable. MC debilitates utilization of hand pumps for drinking water. Hand directs in business sectors fill different needs of the utilization of water. These Hand Pumps are painted red to show the same. MC has given consumable water supply to different segments of market/business places which is for quite a long time in a day.

Table 2.4: Water Quality Analysis of Drains/STP (2016)

Parameters	Sukhna lake	Attawa	Sukhna Choe /Drain	PKR	Baltana	Lake - 42	Dhanas Lake (D1)	Diggian Tertiary Treatment	Diggian	3 BRD	Raipur Khurd	Raipur Kalan
pH	7.9	7.5	7.8	7.6	7.3	8.6	7.5	7.5	7.7	7.3	7.9	7.4
DO (mg/l)	<1	1.8	<1	<1	<1	5.2	<1	<1	1.1	<1	<1	<1
COD (mg/l)	40	96	101	400	61	20	32	44	105	263	97	307
BOD (mg/l)	8	40	28	141	22	4	13	13	28	71	31	92
TSS (mg/l)	14	90	55	270	45	15	40	30	50	120	28	25
NH3-N(mg/l)	1.2	5.6	3.5	18.2	2.6	BDL	1.6	1.8	3.2	8.5	3.6	12.4
NO3-N(mg/l)	2.1	1.9	2.6	1.8	3.1	BDL	2.1	1.3	1.5	2.1	2.1	1.7

Source: Chandigarh Pollution Control Committee (Dec 2016) [39]

2.8 WASTE WATER CONSERVATION AND TREATMENT PRACTICES IN CHANDIGARH

The city of Chandigarh has an all around arranged underground system of channels for the transfer of sewerage produced in the city. It is compulsory for each private/non private.

The sewerage arrangement of the city has been planned by considering the characteristic slant of the city, which is from north to south. The sewage of The city streams under gravity in different funnels of various distance across going from 6" to 18" S.W.Pipes and 24"x36" to 66" dia roundabout Brick sewer. The aggregate length of the sewer lines in the city is 890 km. The sewage is conveyed to a site in the south of the city where a plant has been built for its treatment and the treated sewage is than arranged off in an open Nallah. There are few pockets in the city which are at bring down level and in this way the sewage of these pockets can't be released under gravity into the sewerage arrangement of The city. The sewage of these pockets is drawn into the sewerage framework and from there on it streams under gravity to the Sewage Treatment Plant.

The Sewage Treatment Plant, spread over a zone of 48 sections of land, is situated at Sector 66 of S.A.S. Nagar in Punjab Territory which is at a separation of around 4 km from the closest arranged Sector 47. The present limit of the Sewage Treatment Plant is 30 MGD albeit around 48 mgd sewage is gotten at the Sewage Treatment Plant. The sewage got at S.T.P. is subjected to essential, optional and tertiary treatment. Out of the 48 mgd sewage got at the Sewage Treatment Plant, 35 mgd is dealt with upto optional level and out of this 10 mgd is additionally treated upto tertiary level. The tertiary treated sewage is reused back to the city for water system of open spaces/gardens. The Secondary treated sewage is arranged off in an open Nallah. There were visit break downs in the supply of tertiary treated water because of spillages in the line. Zero speed valves have been given in the line to keeping away from break downs.

2.9 STORM WATER DRAINAGE IN CHANDIGARH

The city has well laid out under ground storm water seepage framework. The Storm Water Drainage System has been composed keeping in see the incline of the city i.e. from North West to South East. It was at first intended for a rain force of half inch every hour [36]. Notwithstanding, on account of the expanded green zones/open spaces going under development, the keep running off co-proficient has expanded enormously. This has brought about the over stacking of tempest water seepage framework and thus flooding of low lying pockets in the city. The Corporation had led a study and recognized 35 such pockets.

The storm water waste framework in these pockets have been increased by giving extra lines and street ravines. So as to meet the circumstance of flooding, it had been wanted to expand the principle trunk lines running from North to South. One trunk principle running between part 17 and 18, 21 and 22, 34 and 35, 43 and 44 and releasing in the N-Choe in division 51 has been laid at a cost of about Rs.2 crores. To expand the waste framework extra lines have been given in division 7, 8, 15, 24, 28, V3 street isolating part 34 and 44, 38, 41. Extra lines have additionally been given on street prompting railroad station. Around 500 vertical street ravines have been given to build the admission of water in the tempest water lines. The tempest water channels have likewise been given in Rehabilitation state Maloya, Janta and Kumhar Colony segment 25.

2.10 NEED FOR DUAL PLUMBING SYSTEMS IN CHANDIGARH

The objectives incorporates the review appraisal of dual water frameworks which are two conveyance frameworks working mutually, one to supply consumable and the other to supply non-consumable water. While double frameworks can be utilized to disperse any source of non-consumable water, the evaluation of their execution for this report concentrates on recycled water, which is the most widely recognized source.

From the future point of view, the Chandigarh city have to adopt dual plumbing system which comprises of treated waste water and fresh water for various household purposes. In dual water system, one pipeline consists of fresh water for bathing purpose, drinking etc. and second pipeline consists of treated water which can be used for gardening, car washing, flush water etc.

As the rising demand of water usage in Chandigarh, we have to look forward for saving water by conserving it either in the form of storm water conservation or waste water treatment for the future use of our generation.

2.11 URBAN WATER SUPPLY AND DEMAND: THE INCREASING GAP

Flooding in general and urban flooding ended up normal occasion in world and in India. Un-even circulation of precipitation combined with quick and impromptu urbanization, infringing upon and topping off characteristic seepage channels and urban lakes to utilize the high-esteem urban land for structures are the reason for urban flooding. The illicit filling of urban water bodies in urban communities like Calcutta, Delhi and Chandigarh and so on is an unchecked.

Tempest water administration has turned out to be complex phenomenon particularly in urban situation where land costs are high.

Particularly in urban areas like Chandigarh, India, where spontaneous settlements are more typical in low laying regions which are water bodies once upon time. Coordinated stormwater administration is just reasoning about the greater part of the elements that by one means or another influence precipitation as it moves from the land surface to a possible getting water. It is the way toward representing these components (e.g. rate, volume, quality, ground water affect) in a sensible procedure with the goal that accidental mix-ups are not made that could in the long run hurt an asset. In Integrated Stormwater administration by organizing objectives and activities (in a perfect world through agreement) gives a guide to moving towards an objective condition by distinguishing the interconnected idea of objectives, qualities and desires, dangers and openings, what should be done to deal with the dangers and accomplish the openings, who ought to be dependable, a general course of events for usage.

Water management consequently needs to consider impacts of the anticipated environmental change and increment in urban water request and search for elective supply alternatives, notwithstanding executing diverse water request administration procedures. With a specific end goal to increment dependable water supplies for the urban communities, reused water should be substituted for existing drinking quality supplies to industry, public parks and games grounds; substituted for some local uses through double reticulation frameworks; or be reused again into the drinking water supply framework. The extent of this venture is however constrained to urban storm water [37].

2.12 SUKHNA LAKE REPORT

The Sukhna Lake is a man-made water body created in 1958 by blocking the Sukhna Choe, a seasonal stream coming down from the Sivalik Hills. This lake was largely fed by runoff created by rainwater and the catchment area needs to be maintained in order to retain good water levels throughout the year. But the heavy siltation problem over years has affected the water holding capacity of the lake and has reduced its volume by 56%. Many efforts are being done by forest department of Chandigarh like afforestation of the catchment area [40].

Sukhna Lake at Chandigarh is facing water availability problems in recent years. The lake got dried almost completely during 2017 summer. Since deficit rainfall has been received during 2018 monsoon, there are apprehensions about its drying in the summer. So, present investigations have been carried out to predict the water availability scenario for the lake. The analysis has been carried out using water balance approach.

Table 2.5 : Estimated water balance components for post monsoon months of 2018-2019

Month	Expected lake storage on the first day of the month (Ham)	Total expected evaporation losses (Ham)	Assumed Pumping Losses (Ham)	Expected volume of water due to rain falling directly over the lake (Ham)	Expected lake storage on the last of the month (Ham)
Oct-2018	221.34	26.16	2.5	3.5	196.25
Nov-2018	197.21	19.23	2.5	1.9	176.80
Dec-2018	176.87	15.09	1	3.8	165.15
Jan-2019	166.32	13.34	1	7.2	159.31
Feb-2019	159.20	17.86	2	6.9	147.20
Mar-2019	144.21	31.15	2	5.7	117.41
Apr-2019	119.47	39.23	2.5	2.7	76.15
May-2019	78.31	39.65	3	5.5	40.75
Jun-2019	42.56	24.61	3	21.3	33.40

Table 2.5 presents the predicted water levels and corresponding expected lake surface areas for different months of the summer of 2019. The expected surface areas have also been presented as percent of maximum surface area of the lake. Thus, it can be observed that by the end of June, the surface area of the lake is likely to be only about 70% of the maximum surface area of the lake, with not all of it having water. Some of it shall be exposed dry bed of the lake. About 70% of it is expected to have water and the remaining about 30% is expected to be dry area.
Our study will help the lake related to water crisis in Sukhna in past years. Our planning related to management of water in the Chandigarh, including wastewater and storm water would be helpful for the prediction of water needed for the lake during dry time.

3.0 LITERATURE REVIEW

The review of literature showed that incentives for reclaimed water use include urbanization pressures on water supply sources, diminishing natural water resources, and increasingly stringent wastewater discharge regulations. Reclaimed water is needed especially in dry regions and reclaimed water projects that target large water users are likely to be more feasible.

Topics included in the following paragraphs cover the range of issues required to assess the performance of dual systems including: water quality and public health aspects of dual water distribution; experience with water reuse systems; distribution system asset and operations management; and economics and institutional arrangements of dual distribution systems.

M.I. Lvovich (1973) investigated water balance study which defined the income of water from precipitation and other sources and the loss or out flow of water by means of evapotranspiration which represents the combined loss of water from the earth by means of evaporation and transpiration as well as from other sources.The concept of water balance has recently gained considerable importance among the climatologists, Meteorologists, Geographers, Geologists, Hydrologists and from other disciplines concerned primarily with water problems.

Belinda Hatt et al. (1996) explores on Integrated Storm water Treatment and Re-utilize Frameworks - Stock of Australian Practice. Lately indications of environmental degradation, showing through declining nature of surface and ground water, have been seen in numerous parts of Australia. For instance, the waterways of the Murray Darling Basin and Hawkesbury-Nepean Bowl have weakened to some extent on account of urban water requests and polluted storm water releases (Anderson, 1996). The utilization of water assets in numerous parts of Australia is drawing closer, and in some urban focuses surpassing, the cutoff points of maintainability. Better coordinated management of urban water (supply, wastewater and storm water) is required if the water needs of the normal populace are to be fulfilled without assist decay of nature.

Marsalek J et al. (2006) investigated International report on Storm water management. An international survey of urban storm water management (SWM) practice was conducted for IWA and produced contributions from 18 countries. The fundamental discoveries of the overview incorporate clear signs of an across the board enthusiasm for storm water administration and of the acknowledgment of a comprehensive way to deal with SWM advancing maintainable urban seepage frameworks (SUDS). Particular ramifications of this logic incorporate accentuation on source controls in SWM, change from customary "hard" frameworks to green foundations, requirements for framework support and restoration, arrangement of storm water offices (inside bigger coordinated water offices) with interest of both open and private areas, and reasonable subsidizing through seepage expenses as opposed to general duties. Further progress in this field requires targeted research and development, knowledge sharing, and above all, a high level of public participation in planning, implementing and operating storm water management systems.

Fletcher T. D. et al. (2007) explored storm water harvesting gainful to urban conduit environmental flows. Urbanization debases the hydrology and water nature of conduits. Changes to stream administrations incorporate expanded recurrence of surface spillover, expanded pinnacle streams and an expansion in all out overflow. In the meantime, water use in numerous urban communities is drawing closer, and now and again surpassing, maintainable breaking points. Tempest water reaping can possibly alleviate some of these unfavorable effects. The outcomes demonstrate that utilizing these run of the mill collecting situations brought stream and water quality back towards their pre-created levels. Now and again, in any case, reaping brought about an over-extraction of stream, exhibiting the requirement for advancing the gathering procedure to meet both supply and natural stream destinations. The outcomes demonstrate that urban tempest water reaping is a potential system for accomplishing both water preservation and natural streams.

Zhuo CHEN et al. (2007) identified analysis of Sydney’s recycled water schemes. Recycled water provides a viable opportunity to partially supplement fresh water supplies as well as substantially alleviate environmental loads. Currently, thousands of recycled water schemes have been successfully conducted in a number of countries and Sydney is one of the leading cities, which has paid great effort in applying waterreclamation, recycling and reuse. This study aims to make a comprehensive analysis of recycled water schemes in Sydney for a wide range of end uses such as landscape irrigation, industrial process uses and residential uses (e.g. golf course irrigation, industrial cooling water reuse, toilet flushing and clothes washing etc.). For each representative recycled water scheme, this study investigates the involved wastewater treatment technologies, the effluent water quality compared with specified guideline values and public attitudes towards different end uses. Based on these obtained data, multi criteria analysis (MCA) in terms of risk, cost-benefit, environmental and social aspects can be performed. Consequently, from the analytical results, the good prospects of further expansion and exploration of current and new end uses were identified towards the integrated water planning and management. The analyses could also help decision makers in making a sound judgment for future recycled water projects.

Daniel Hellstrom et al. (2008) examined a structure for frameworks investigation of sustainable urban water management. The expanding interest for economical advancement will profoundly affect a wide rangeof urban foundations. Be that as it may, there is an absence of learning of how supportable improvement ought to be achieved and how maintainability of different specialized frameworks ought to be surveyed. This paper portrays the structure of a frameworks investigation venture managing the above issues, which concentrates on urban water and wastewater frameworks. The task is a piece of substantial national research program in Sweden entitled "Maintainable Urban Water Administration." This paper recommends reasonable markers for the proposed criteria. It additionally contains a concise examination of the commitment to different natural impacts and asset usage of the Swedish urban water framework in connection to the effect of Swedish society altogether, to take into account a right prioritization of the criteria.

Joel Stewart et al. (2009) described Assessing supply risks of recycled water allocation strategies. A tool to evaluate the supply dangers related with water designation systems utilized at emanating reuse offices is portrayed. The tool is a month to month water adjust model and affectability investigation. Through examination of atmosphere records at the Hawkesbury water reuse conspire site (the area of a consolidated profluent and tempest water reuse office), it was discovered that a gauge of water system request took after standard factual appropriations. The assessed dissemination of water system request was utilized as a part of conjunction with a water adjust model to evaluate future storage distributions and thus dangers of future over-or under-supply situations. The tool is reasonable for use in an operational environment to assess the impact of demand management strategies.

Shiroma et al. (2010) states anIntegrated Urban Water Management is an emerging approach for urban water utilities to plan and manage urban water systems to minimize their impact on the natural environment, to maximize their contribution to social and economic vitality and to engender overall community improvement. The obvious starting point for adopting the IUWM approach is the strategic planning phase. However, little has been written on processes that enable application of the IUWM approach to planning. Identifying this knowledge gap, the Water Research Foundation and the CSIRO, Australia jointly developed a framework to adopt IUWM approach to strategic planning of urban water systems (referred to as IUWM Planning Framework). This paper discusses principles, drivers and benefits of IUWM approach and provides an overview of the IUWM Planning Framework.

Arghyam Trust, Bangalore (2010) included thorough survey of research embraced everywhere throughout the world on different parts of urban water administration by researchers and specialists, including yet not restricted to urban hydrology, administration of water supply foundation, water assets administration, water quality administration (WQM), groundwater administration, specialized and monetary instruments for water request administration, specialized and financial parts of spillage decrease, ecological and financial parts of wastewater treatment and reuse, storm water administration, limit working for IUWM and legitimate and administrative structures. Essential information accumulation for 27 urban areas/towns and auxiliary information gathering for 300 urban communities/towns was completed, covering all the 16 outlined typologies. Reasonable arrangements of IUWM mediations were distinguished for every typology in view of the comprehension of how the common qualities of these typologies impact the physical, monetary, institutional, money related and natural execution of urban water utilities.

Hatt BE et al. (2012) states an integrated treatment and recycling of storm water as a review of Australian practice.With the utilization of water drawing closer, and at times surpassing, the cutoff points of supportability in numerous areas, there is an expanding acknowledgment of the need to use storm water for non-consumable prerequisites, in this way diminishing the request on consumable sources. This paper exhibits a survey of Australian storm water treatment and reusing rehearses and in addition a discourse of key lessons and recognized information holes. Where conceivable, suggestions for conquering these information holes are given. There is an unmistakable requirement for the advancement of creative systems for the accumulation, treatment and capacity of tempest water. Existing storm water reusing practice is a long ways in front of research, in that there are no advances composed particularly for storm water reusing.

Casey Furlong et al. (2014) justifies the The Integrated Urban Water Management (IUWM) paradigm, including concepts such as water reuse, and Sustainable Urban Drainage Systems, has become popular within Melbourne, and this has created new governance issues. This paper explores the relationship between changing governance structures and IUWM implementation. It is found that IUWM implementation has predominantly been accelerated by: a major drought, and implementing the Office of Living Victoria (OLV) as an overarching body. Efforts by the OLV have increased inter-agency collaboration, and institutionalised integrated planning. However, there is still no consensus on what the specifics of IUWM planning and infrastructure arrangements should actually look like.

Anna Hurlimann et al. (2018) described the provision of a sustainable supply of water is an increasingly difficult task to achieve in many urban environments. This arises because of pressures related to population growth and increased per capita demand for water. Additionally, climate change is impacting the natural cycle of water in many locations, with a significant impact projected for the future. Many scholars advocate 'sustainable urban water management' (SUWM) as an approach that can address the root causes of these challenges. The paper provides information and tools to assist water planners achieve SUWM and a well-adapted water sector and urban environment, in an integrated, holistic and comprehensive manner, to meet future water supply needs. Achieving these goals will need collaborative activities across multiple built environment disciplines.

NitinBassi et al. (2018) features the institutional change requirements for feasible urban water administration in India. The institutional change will include: 1) one or mix of authoritative change measures involving decentralization, private area interest and, network based administration; 2) order changes and; 3) human asset improvement. The better perspectives will rely on the physical and financial condition, political circumstance and managerial set up that exist in the urban territory. The institutional changes will be all the more so vital for little urban towns where open utilities are given little consideration. All these together can add to improving Indian urban communities arranged for turning away the hazard, in face of fast urbanization, environmental change and water shortage.

4.0 RESEARCH GAPS

REGION	ORGANISATION/AUTHOR	TOPIC	FINDING	SHORTCOMINGS
CHANDIGARH	Storm water drainage system, Municipal Corporation, Public Health Division No. 4, Government of India, Chandigarh.	INTEGRATED URBAN PLANNING APPROACH	The Chandigarh Master Plan with a vision for 2031 is being prepared for the city and its immediate periphery, wherein the challenges and the problems affecting the sustainability of the city are being attempted to be addressed holistically in the plan.	They have not discuss yet anything related to proper management of dual water supply in the city.
CHANDIGARH	Dynamic groundwater Resources of India, Central Ground Water Board, Ministry of Water Resources, Government of India, Chandigarh.	Urban water supply	Rooftop rain water harvesting, Utilising monsoon runoff, Schemes approved under central sectors	Not disciussed the proper storage and management of storm water.
CHANDIGARH	ENVIS Centre, Department of	Identification of data gaps	The focus of ENVIS since	Thay have not considered yet

	Environment, Chandigarh Administration, ParyavaranBhawan, Chandigarh.	and knowledge gaps in specified subject areas and action to fill these gaps	inception has been on providing environmental information to decision makers, policy planners, scientists and engineers, research workers, etc. all over the country.	in the reports related to dual water supply in the city and also the treatement of dual water in the same tank.
INDIA	NitinBassi et al.	Institutional Change Needs for Sustainable Urban Water Management in India	Research paper highlights the institutional change needs for sustainable urban water management in India.	Have not focused on water management and reuse process.
INDIA	Arghyam Trust, Bangalore	Tool Kit for Integrated Urban Water Management	Included thorough survey of research embraced everywhere throughout the world on different parts of urban water administration by researchers and specialists.	Have not focused on treated water supply and storm water reuse system.
INDIA	EU Funded Projects	The planning and implementatio	This project is dedicated to capacity building in Indian cities to initiate reforms for integrated approach towards water	Training programmes on water quality testing have been conducted and one portable

		n of water use	supply, water and solid waste management.	water testing kit has been provided. They have not develop techniques realted to storm water and waste water management.
ABROAD	Zhuo CHEN et al.	Analysis of Sydney's recycled water schemes	This study investigates the involved wastewater treatment technologies, the effluent water quality compared with specified guideline values and public attitudes towards different end uses.	They have not discussed about the storm water management.
ABROAD	Shiroma et al.	Integrated Urban Water Management	This paper discusses principles, drivers and benefits of IUWM approach and provides an overview of the IUWM Planning Framework.	Have not worked on dual system yet.
ABROAD	Marsalek J et al.		An international survey of urban	Have not discussed

		International report on Storm water management	storm water management (SWM) practice was conducted for IWA and produced contributions from 18 countries.	anything related to treated water management.
ABROAD	Fletcher T. D. et al.	Storm water harvesting gainful to urban conduit environmental flows	Urban tempest water reaping is a potential system for accomplishing both water preservation and natural streams.	Have not discussed anything related to dual water supply.
ABROAD	Casey Furlong et al.	The Integrated Urban Water Management (IUWM) paradigm	Includes concepts such as water reuse, and Sustainable Urban Drainage Systems, has become popular within Melbourne, and this has created new governance issues.	Still no concerns on what the specifics of IUWM planning and infrastructure arrangements should actually look like.

5.0 RESEARCH HYPOTHESIS

1. It is itpossible to do a water balance study for Chandigarh with reasonable accuracy.
2. The stakeholders agree that the principles of IUWM can be applied to Chandigarh.
3. It is possible to apply frameworks and models to test pilot applications of IUWM in Chandigarh.

6.0 RESEARCH OBJECTIVES

Based on the hypothesis stated above following are the objectives of the study:

1. To carryout water balance study of Chandigarh.
2. To quantify sustainable sourcing of water and effective use of multiple sources such as rain water, surface water, ground water and treated water in Chandigarh.
3. To ensure availability, equitable provisioning and efficient distribution of integrated water.
4. To use waste water as resource effectively.
5. To apply frameworks and models to test pilot applications of IUWM in Chandigarh.

7.0 RESEARCH METHODOLOGY

7.1 Identify the places in Chandigarh

a) Sukhna Drain
b) Patiala ki Rao Drain
c) STP Diggian Outlet (30 MGD)
d) STP Raipur Khurd Outlet (1.25 MGD)
e) STP Raipur Kalan Outlet (5 MGD)
f) STP Dhanas Outlet (1.6 MGD)

Proposed Areas:

a) Khuda-ali-sher (1.7 MGD)
b) Diggian Mohali (15 MGD)

Places includes North Chandigarh, South Chandigarh, East Chandigarh and West Chandigarh from where we can collect 2 samples each and then further we can do testing of that samples to get the accurate results.

7.2 Type of data to be collected

TYPE	RAINFALL	WASTE WATER	STORM WATER	GROUND WATER	TREATED WATER
Department	Meteorological	CPCB	CPCB	ENVIS	MC

1.3 Sample of Data Collection

Collection of data includes the rainfall, wastewater, stormwater, ground water and treated water from the various organisations working in Chandigarh. The primary data related to water characteristics prevailing in study area are generated through various tools like on-site observations related to water sample collection, laboratory testing, questionnaires and interviews are conducting in the progressive manner. Water samples are collected from various STPs and drains to check the quality of water.

7.4 List of organisations working in this field and type of data they have.

Institutional Organisations
Environmental Information System
Chandigarh Water Resources
Environment Protection Authority
Municipal Corporation
Local Government
Land Developers
Consultants

7.5 Frequency Period

It includes 3 months period and upto 5 years of data analysis in which we can find the maximum and minimum values on matlab. We can collect the data of 5 years and then divide that data into January to March, April to June, July to September and October to December.

7.6 Data Analysis

In the data analysis, use the statistical approach by using Matlab, MSExcel to figure out the results for the future. In this we require data of 5 years to analyse it properly. We also use some hydrological equations to get results properly.

1. **Sustainable sources of water**
   a) By storing water in tanks or ponds and water bodies.
   b) The network receives more than 70% of the total rainfall received in the city. Thus, this will be an effective way to augment the city's water resources.
   c) Use of recycled water will be compulsory for all non-potable uses for all large buildings in all new developments. If such water is not supplied by the MC then the building should set up water treatment plant within its premises for reuse of waste water.

d) Construct Green Roofs that reduce the volume and rate of runoff and remove pollution.

2. To develop a method of using this combined water.

Consider the project for this study which would be helpful for the water management in the city. It includes Sukhna Lake and Zirakpur area to finally implement our results and make this thesis helpful for future water crisis and future generation too.

8.0 WORK DONE SO FAR

8.1 SURVEY OF RESIDENTIAL MULTI STOREY

BUILDING NAME: EXOTICA HEIGHTS

BUILDING WATER CAPACITY: 112 KLD

- 83 KLD (For fresh water)
- 29 KLD (Treated water)

POPULATION EXPECTED: 700 Nos.

DOUBLE PLUMBING SYSTEM:

- One pipeline for fresh water
- One pipeline for latrines and other use (using treated wastewater)

STORAGE TANKS: USING STORM WATER AND RAIN WATER

- DIMENSIONS = 5.50m*5.50m
- Depth = 5m

STORAGE TANK CAPACITY: 3.50 lacs litre

TREATMENT PLANT: 8m*13.5m*3m

The design process should aim to:

- Design the reuse scheme for ease of operations and maintenance.
- Cost-effectively meet the project's objectives identified during project planning.

8.2 WATER QUALITY TESTING RESULTS

Table 8.1: SUKHNA LAKE (2017-2018)

Sr. No.	Parameters	Unit	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1	pH	-	-	-	-	-	-	-	-	7.8	7.4	7.4	6.7	8.2
2	Conductivity	µs/cm	152	137	176	142	218	179	205	178	180	202	224	244
3	DO	mg/l	6.9	8.2	9.7	8.6	6.9	7.2	7.9	8.8	5.1	9.2	7.9	8.7
4	COD	mg/l	24	-	20	-	24	-	40	17	28	36	48	69
5	BOD	mg/l	9	-	3	-	7	-	10	5	2	2	3	3
6	NO_3-N	mg/l	0.42	5.20	0.32	1.24	0.42	1.10	0.34	1.50	0.28	4.80	0.73	0.90
7	NH_3-N	mg/l	0.88	3.60	0.92	3.20	0.89	2.60	0.76	1.10	0.52	0.52	0.45	0.77
8	Phosphate	mg/l	ND	<1	0.08	<1	0.10	<1	0.11	0.08	0.05	0.03	0.07	0.06
9	Total Suspended Solid	mg/l	32	35	20	44	15	50	12	30	22	12	19	28
10	TDS	mg/l	115	90	92	98	125	116	163	149	92	93	116	157
11	TFS	mg/l	56	64	48	62	80	73	86	95	75	87	29	136
12	Turbidity	NTU	2	66	10	40	15	45	10	55	27	28	29	52
13	TH as $CaCO_3$	mg/l	64	37	50	42	45	47	44	270	76	92	118	120
14	Ca as $CaCO_3$	mg/l	35	23	30	26	25	29	29	180	16	72	68	64
15	Mg as $CaCO_3$	mg/l	30	14	20	16	20	18	12	90	60	20	50	56
16	Sulphate	mg/l	15.70	15.00	19.00	19.00	13.10	16.00	17.00	15.03	12.78	8.91	10.63	14.25
17	Chloride	mg/l	10	3	10	5	7	12	14	18	10	7	9	14
18	P-Alkalinity	mg/l	Absent	8	20	8	30	Nil	15	6	6	16	6	Nil
19	Total alkalinity as $CaCO_3$	mg/l	78	62	80	68	90	74	75	172	180	150	104	138
20	Fluoride	mg/l	0.47	0.29	0.40	0.21	ND	0.19	0.21	BDL	0.09	BDL	0.23	BDL
21	colour	Hazen	5	5	20	5	10	10	15	20	<5	<5	<5	<5
22	Boron(B)	mg/l	ND	<1	ND	<1	ND	<1	ND	<1	ND	<1	ND	0.05

23	TKN	mg/l	2.53	5.00	1.88	5.90	1.50	5.70	1.32	5.40	1.82	4.70	4.20	7.40
24	Potassium	mg/l	3	4	2	5	5	6	6	7	6	4	5	5
25	Sodium	mg/l	18	25	17	34	30	40	36	40	12	17	20	20
26	TOTAL COLIFORM	MPN/100	--	--	--	--	--	--	--	--	--	<2	--	<2
27	FAECAL COLIFORM	MPN/100	--	--	--	--	--	--	--	--	--	<2	--	<2

Table 8.2: SUKHNA CHOE/DRAIN (2017-2018)

Sr. No.	Parameters	Unit	Permisible Limit	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1	pH	-	5.5 to 9.0	7.5	7.3	7.5	7.3	7.2	7.3	7.7	7.5	7.4	7.1	7.5	7.4
2	Conductivity	µs/cm	--	612	794	913	872	1309	624	489	1084	1003	973	1015	428
3	DO	mg/l	--	2.20	<1	Absent	<1	Absent	2.0	0.7	NIL	NIL	NIL	0.2	2.1
4	COD	mg/l	250	114	144	157	141	176	148	80	330	248	310	318	307
5	BOD	mg/l	30	24	46	42	46	50	42	22	203	77	99	132	133
6	NO_3-N	mg/l	10	0.49	1.50	0.91	0.47	0.84	1.50	0.34	1.10	0.25	2.70	0.92	1.40
7	NH_3-N	mg/l	50	1.52	1.50	1.81	1.16	1.56	0.98	0.96	36.69	33.84	35.01	28.29	8.85
8	Phosphate	mg/l	5	1.28	<1	2.90	0.51	3.50	0.19	1.29	9.01	4.40	3.01	5.26	1.51
9	Total Suspended Solid	mg/l	100	26	160	59	170	75	160	32	100	170	62	90	105
10	TDS	mg/l	--	337	516	449	562	720	405	286	639	496	515	389	274
11	TFS	mg/l	--	195	315	289	298	395	315	129	410	375	408	351	152
12	Turbidity	NTU	--	42	30	80	40	65	75	29	83	47	78	105	190
13	TH as $CaCO_3$	mg/l	--	134	210	208	206	280	212	118	72	234	268	268	270
14	Ca as $CaCO_3$	mg/l	--	109	124	139	125	190	136	83	50	198	152	194	104
15	Mg as $CaCO_3$	mg/l	--	25	85	69	93	90	76	34	22	36	116	70	166
16	Sulphate	mg/l	--	25.70	30.00	72.00	28.00	96.00	25.00	33.00	50.72	40.37	49.25	59.88	54.42
17	Chloride	mg/l	--	24	58	68	54	80	53	30	69	71	52	58	24
18	P-Alkalinity	mg/l	--	ND	<1	ND	<1	ND	<1	ND	Nil	12	28	8	Nil
19	Total alkalinity as $CaCO_3$	mg/l	--	267	373	360	380	420	349	105	452	406	404	404	150
20	Fluoride	mg/l	2	0.22	0.21	0.14	0.21	0.19	0.25	0.21	BDL	0.29	0.59	0.34	0.72

21	colour	Hazen	--	50	-	65	15	105	30	30	60	30	30	30	30
22	Boron(B)	mg/l	--	ND	<1	ND	<1	ND	<1	ND	<1	ND	<1	0.19	0.17
23	TKN	mg/l	--	2.89	3.10	2.62	2.50	2.10	2.80	1.86	2.70	1.72	2.70	2.20	2.10
24	Potassium	mg/l	--	13	4	18	4	24	5	29	1	17	4	4	5
25	Sodium	mg/l	--	31	16	49	16	80	20	93	4	52	19	15	18
26	Total Coliform	MPN/100	--	5.2×10^{5}	1.4×10^{5}	4.4×10^{6}	1.4×10^{6}	5.2×10^{6}	4.0×10^{4}	6.2×10^{6}	9.4 x 10^{4}	4.3×10^{6}	1.1×10^{5}	5.4×10^{5}	1.7×10^{5}
27	Faecal Coliform	MPN/100	--	3.9×10^{5}	9.3 x 10^{4}	3.8×10^{6}	1.1×10^{6}	4.4×10^{6}	2.0×10^{4}	4.9×10^{6}	6.9 x 10^{4}	3.5×10^{5}	4.0×10^{4}	1.1×10^{5}	9.3 x 10^{4}

Table 8.3: PATIALA KI RAO CHOE/DRAIN (2017-2018)

Sr. No.	Parameters	Unit	Permisible Limit	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1	pH	-	5.5 to 9.0	7.2	7.4	7.5	7.7	7.4	7.7	7.3	7.6	7.7	7.5	7.8	6.6
2	Conductivity	µs/cm	--	891	800	1049	852	1054	766	1032	644	589	950	1091	1080
3	DO	mg/l	--	Absent	<1	Absent	<1	Absent	<1	Absent	0.20	0.81	NIL	NIL	NIL
4	COD	mg/l	250	176	202	186	206	194	212	200	230	298	396	530	610
5	BOD	mg/l	30	71	75	87	82	72	79	80	58	72	172	298	299
6	NO_3-N	mg/l	10	0.26	6.60	0.33	1.30	0.21	5.00	0.36	8.10	0.31	6.30	0.86	5.00
7	NH_3-N	mg/l	50	1.62	6.50	1.12	5.40	1.71	5.10	1.56	15.58	13.82	26.53	39.25	41.43
8	Phosphate	mg/l	5.0	4.14	2.30	4.29	2.01	4.08	1.81	7.90	1.49	1.12	2.61	4.03	6.44
9	Total Suspended Solid	mg/l	100	97	100	89	100	105	90	110	220	477	277	336	715
10	TDS	mg/l	--	600	521	570	560	655	498	576	268	304	515	559	519
11	TFS	mg/l	--	189	300	164	334	154	348	175	309	718	553	615	1410
12	Turbidity	NTU	--	64	55	80	65	55	70	99	230	495	260	278	380
13	TH as $CaCO_3$	mg/l	--	272	252	252	249	285	250	245	230	162	246	276	312
14	Ca as $CaCO_3$	mg/l	--	178	157	153	154	175	151	167	188	88	220	244	212
15	Mg as $CaCO_3$	mg/l	--	94	95	99	95	110	99	75	88	74	26	32	94
16	Sulphate	mg/l	--	58.00	21.00	44.40	20.00	45.60	16.00	39.80	--	91.08	56.78	72.29	62.19
17	Chloride	mg/l	--	57	45	49	39	51	42	70	35	33	58	59	49
18	Total alkalinity as	mg/l	--	485	437	440	440	480	466	422	266	546	444	476	446

	$CaCO_3$														
19	P-Alkalinity	mg/l	--	ND	<1	ND	<1	ND	Nil	ND	Nil	Nil	22	16	22
20	Fluoride	mg/l	2.0	0.27	0.39	0.36	0.35	0.22	0.39	0.72	BDL	0.28	0.58	0.28	0.33
21	colour	Hazen	--	40	20	50	20	30	25	80	-	60	30	50	60
22	Boron (B)	mg/l	--	ND	<1	ND	<1	ND	<1	ND	<1	ND	<1	0.22	0.19
23	TKN	mg/l	--	2.08	9.50	1.73	9.40	2.19	9.10	2.08	9.90	1.97	10.10	8.30	8.70
24	Potassium	mg/l	--	19	41	13	41	15	43	20	35	8	45	45	42
25	Sodium	mg/l	--	62	80	62	90	55	93	78	73	38	97	93	85
26	Total Coliform	MPN /100	--	2.5×10^5	9.3×10^4	2.3×10^5	1.1×10^6	2.55×10^5	$9.4 x 10^4$	2.71×10^5	1.4×10^4	2.4×10^5	8.0×10^4	7.6×10^4	1.7×10^5
27	Faecal Coliform	MPN /100	--	1.7×10^5	6.9×10^4	1.3×10^5	9.3×10^5	1.62×10^5	$6.9 x 10^4$	1.63×10^5	1.1×10^4	1.0×10^5	$6.1 x 10^4$	$5.4 x 10^4$	1.4×10^5

Table 8.4: STP DIGGIAN OUTLET (2017-2018)

Sr. No.	Parameters	Unit	Permisible Limit	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1	pH	-	5.5 to 9.0	7.6	7.5	7.3	7.0	7.4	7.3	7.2	6.3	7.3	7.9	7.1	7.3
2	DO	mg/l	-	4.9	3.2	4.1	4.2	3.2	4.5	4.3	6.3	4.1	3.6	4.5	4.5
3	COD	mg/l	250	128	82	120	89	127	83	100	90	87	148	142	180
4	BOD	mg/l	30	32	25	48	27	31	32	26	37	29	49	27	55
5	TSS	mg/l	100	38	85	32	75	56	80	49	66	58	25	49	85
6	Total Nitrogen	mg/l	-	1.80	13.90	1.36	13.50	1.42	13.70	1.22	13.90	1.40	-	-	-
7	NH_3-N	mg/l	50	1.12	6.60	0.80	8.10	0.92	7.90	0.76	26.15	23.65	26.1	29.96	27.33
8	PO_4-P	mg/l	5.0	2.43	1.60	3.20	2.14	3.39	2.59	2.01	4.09	2.35	1.98	1.80	2.1
9	Faecal Coliform	MPN/100ml	-	1.0×10^5	4.0×10^4	9.6×10^4	8.3×10^4	1.1×10^5	6.9×10^4	1.1×10^5	4.5×10^2	2.3×10^5	2.1×10^1	1.1×10^3	4.06×10^2
10	Total Coliform	MPN/100ml	-	-	-	-	-	-	-	-	-	-	-	2.01×10^3	6.93×10^2

Table 8.5: STP RAIPUR KHURD OUTLET (2017-2018)

Sr. No.	Parameters	Unit	Permisible Limit	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1	pH	-	5.5 to 9.0	7.4	7.3	7.3	7.2	6.7	7.4	-	-	7.4	6.8	7.2	7.5
2	DO	mg/l	-	1.9	<1	1.1	<1	Absent	<1	-	-	0.93	NIL	0.50	0.49
3	COD	mg/l	250	205	82	118	78	136	82	-	-	190	292	308	230
4	BOD	mg/l	30	41	24	38	29	45	26	-	-	54	73	82	122
5	TSS	mg/l	100	89	50	72	50	57	50	-	-	127	58	97	92
6	Total Nitrogen	mg/l	-	1.49	14.50	1.05	7.20	1.21	14.00	-	-	1.98	13.90	-	-
7	NH_3-N	mg/l	50	0.36	7.50	0.45	2.10	0.53	7.10	-	-	45.68	34.72	23.32	36.91
8	PO_4-P	mg/l	5.0	4.18	2.61	4.89	14.80	4.36	0.92	-	-	2.46	3.75	0.81	3.67
9	Faecal Coliform	MPN/100ml	-	1.01×10^5	6.1×10^4	1.1×10^5	4.0×10^5	1.1×10^5	2.7×10^5	-	-	1.6×10^6	6.9×10^2	1.1×10^3	1.1×10^3
10	Total Coliform	MPN/100ml	-	-	-	-	-	-	-	-	-	-	-	2.2×10^3	1.7×10^3

Table 8.6: STP RAIPUR KALAN OUTLET (2017-2018)

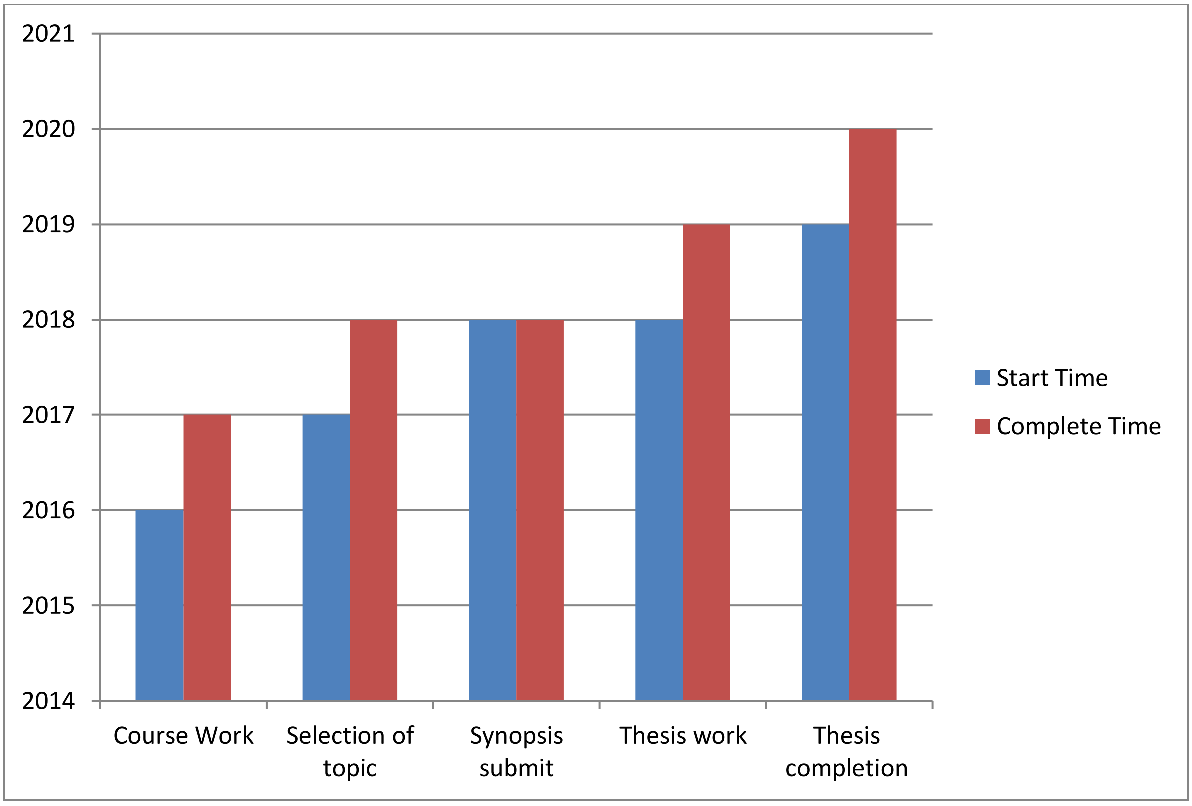
Sr. No.	Parameters	Unit	Permisible Limit	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1	pH	-	5.5 to 9.0	7.1	7.3	7.2	-	-	7.0	7.4	7.1	6.9	6.8	7.0	7.3
2	DO	mg/l	-	Absent	<1	ND	-	-	<1	Absent	NIL	NIL	0.64	NIL	2.2
3	COD	mg/l	250	130	103	127	-	-	74	220	318	178	358	418	178
4	BOD	mg/l	30	80	31	62	-	-	27	46	80	98	98	94	72
5	TSS	mg/l	100	39	45	24	-	-	55	31	109	123	89	252	47
6	Total Nitrogen	mg/l	-	1.92	12.40	2.01	-	-	14.00	1.72	13.70	2.49	12.10	-	-
7	NH_3-N	mg/l	50	0.82	6.40	0.99	-	-	5.80	0.86	28.61	31.06	34.72	27.85	31.36
8	PO_4-P	mg/l	5.0	4.12	2.90	4.33	-	-	0.70	6.71	10.34	3.02	3.75	4.55	3.43
9	Faecal Coliform	MPN/100ml	-	1.2×10^5	4.0×10^4	1.4×10^5	-	-	2.7×10^5	1.4×10^5	4.5×10^4	1.8×10^5	4.0×10^4	4.0×10^3	2.0×10^4
10	Total Coliform	MPN/100ml	-	-	-	-	-	-	-	-	-	-	-	2.0×10^4	3.2×10^4

Table 8.7: STP DHANAS OUTLET (2017-2018)

Sr. No.	Parameters	Unit	Permisible Limit	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.
1	pH	-	5.5 to 9.0	7.3	-	8.0	7.9	7.2	7.8	7.5	7.8	7.8	6.7	7.8	6.8
2	DO	mg/l	-	3.2	-	5.1	4.9	6.0	5.1	3.6	5.3	3.7	5.7	3.4	5.7
3	COD	mg/l	250	157	-	170	78	108	74	60	134	194	79	116	102
4	BOD	mg/l	30	31	-	45	23	22	32	12	21	28	10	29	10
5	TSS	mg/l	100	84	-	75	20	52	25	46	14	37	8	12	14
6	Total Nitrogen	mg/l	-	1.13	-	1.02	9.50	1.01	9.90	0.98	9.10	0.89	-	-	-
7	NH_3-N	mg/l	50	0.82	-	0.66	3.80	0.56	3.40	0.32	13.97	20.40	7.10	11.05	9.01
8	PO_4-P	mg/l	5.0	2.19	-	2.54	0.82	2.09	1.32	5.10	1.79	0.97	0.33	0.93	0.13
9	Faecal Coliform	MPN/100ml	-	0.98×10^5	-	0.87×10^5	-	0.81×10^5	9.3×10^2	0.68×10^5	6.1×10^4	3.5×10^5	4.5×10^4	1.1×10^3	6.9×10^3
10	TOTAL COLIFORM	MPN/100ml	-	-	-	-	-	-	-	-	-	-	-	2.3×10^3	9.3×10^3

Note- plant was not working in the month of feb.due to maintenance of plant.

9.0 BAR CHART


2021
2020
2019
2018
2017
2016
2015
2014
Course Work
Selection of topic
Synopsis submit
Thesis work
Thesis completion
Start Time
Complete Time

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