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# Built Environment along the Contemporary Riverfront Spaces: A Guideline for Riverfront Areas

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**Abstract:** In this world we need five elements (earth, air water sky and fire) for a living environment. All elements create an environment of livable things (human, animal, trees etc.) water effects the environment. We got gifted by having river, lakes, natural water resources, underground water resources, sea and etc. Water is an important defining element of settlements across the world and can be traced back through a city's historical structure and morphology. Water, as one of the main effects of life has long been interested in different cultures, as in many civilizations, we could find legends about emergence and development or relationship between water with the creation of the universe. The study indicates the relationship between a city and its waterfront is unique and always changing, depending on the functions carried out on adjoining land. The aim of this dissertation is to be established significance of riverfront development in urban and rural areas in a particular aspect of need and design where the society can get the spaces according to their need and infrastructure improvement. Also, those spaces may affect the social, environmental and economic aspects.in this research basically describes the riverfront morphology of spaces along river and their type of development need, guidelines which may follow in such kind development to improvise some cause and problems which are facing in recently or past built projects. The literature study helps to find out specific solution and techniques to avoid some basic or important causes along the riverfront spaces.in urban area we can see almost high percentage of green zone development along the river cause of less green spaces in urban area and also society need it, but in rural there are no such kind of specification of development category and typology, and also they are facing such kind of problems like flood, sewage, bio hazardous kind of atmosphere etc.so all the study defines the conclusion for a guideline which may support the development of built space and riverfronts in both area (urban and rural ) to get a improved and good kind of built atmosphere.

**Keywords:** Riverfront, Riverfront Spaces, Development, Built Environment, Waterfront, Guidelines, Urban, Rural Built Spaces, Riverbed, Morphology of Riverfront, Riverfront Development.

## I. INTRODUCTION

In this world we'd like 5 parts for a living atmosphere. All parts produce associate atmosphere of liveable things (human, animal, trees etc). Water effects the atmosphere. We tend to got talented by having stream, lakes, natural water resources, underground water resources, ocean and etc. Water is a important process component of settlements across the planet and may be derived back through a city's historical structure and morphology. The connection between a town and its city district is exclusive and forever dynamic, looking on the functions allotted on connected land. (author)

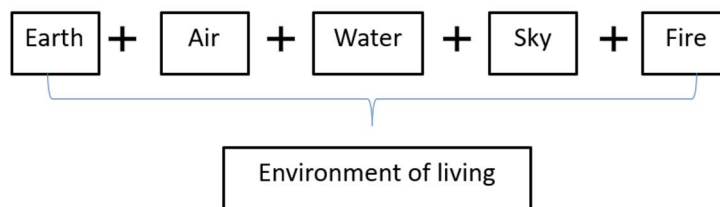


Figure 1-Elements for Living Environment

### A. Natural

- 1) Water is available in three forms on the environment: solid (snow), liquid (water) and gases (water vapour).
- 2) Water is a very important medium for all the life processes. personalities depend upon water for drinking, cooking, cleaning, agriculture, transportation, hydropower etc.
- 3) Water acts as a resolvent and gases like O, nitrogen, greenhouse gas and solids like salts get without delay dissolved with water.
- 4) There square measure 2 styles of liquid water mainly- salt, and fresh.
- 5) Freshwater is obtained from fresh water, surface water and well water. (DEVELOPMENT R. , 2020)

**B. Architectural**

Water plays a really necessary role among the formation of human life. however, once we go ahead and are available to design, water finds a special place from the creative purpose of read. Water is obvious, fluid, calm and quiet.

**C. The Role Of Water Within The Previous Myths**

Water, in concert of the most effects of life has long been inquisitive about totally different cultures, as in many civilizations, we tend to may notice legends regarding emergence and development or relationship between water with the creation of the universe. (author)

**II. RIVER, AND ROLE OF RIVERFRONT SPACE**

RIVER Are the only form of water who originate from drought places like hills in naturally and end in ocean (the biggest form of water). On terrain everything is in slope starts from hills (maximum slope height all due to gravity) and go towards minimum slope area ocean and terrain fields.

When rain falls on the land, it either seeps into the bottom or becomes runoff, that flows downhill into rivers and lakes, and towards the seas. River provides the life sustaining resources to environment E.g.: water for farming, farm land, Minerals and resources, Water animals fish and others and also used as transportation in past and present time also. (author)

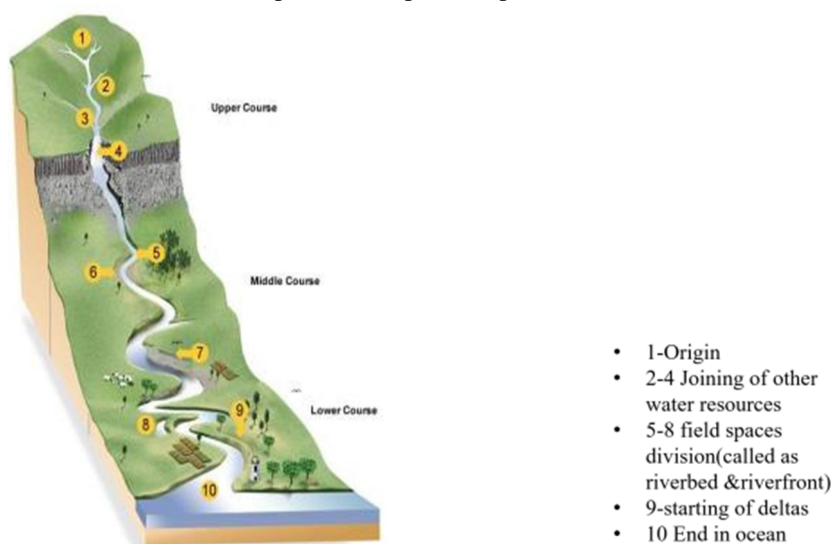


Figure 2- River Formation

“River Makes Its Path Naturally by Dividing the Lands and This Division Along the River Called as Riverfront Spaces & Riverbeds”

**A. Natural**

Riverbeds or Riverfront Having Tress, Field, Farms, forest, Lakes and Etc. Which Are Naturally Created E.g.: Delta, Island Etc.

**B. Man-made**

Formatted as Per Evolution and Used by Humans by Addition And Subtraction Of Spaces. e.g.: hardscapes, Ghat, Resort and All.



Figure 3- Natural Riverfront



Figure 4- Man Made Riverfront



### III.RIVERFRONT TYPES

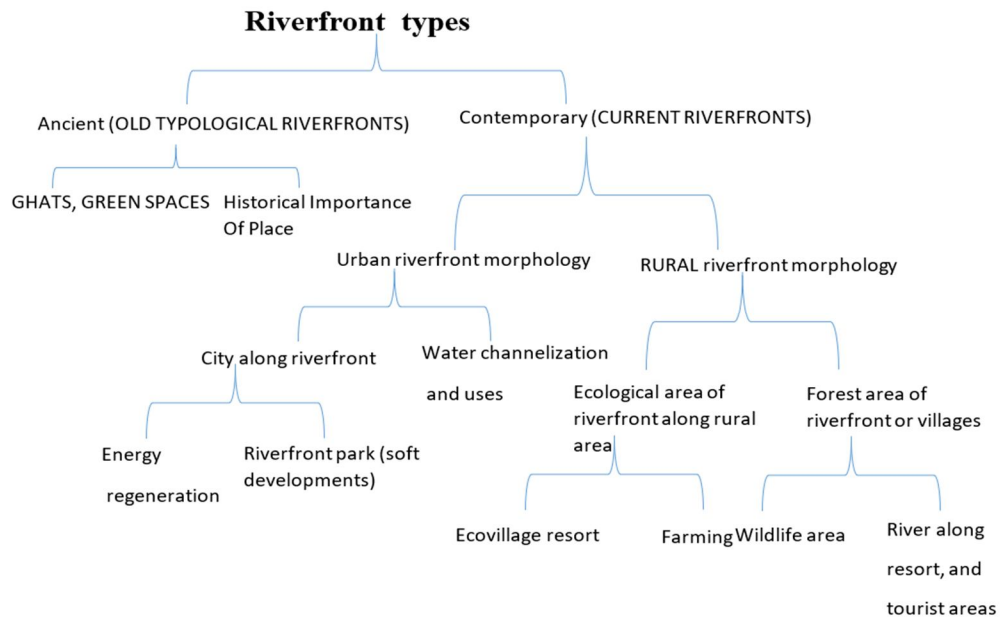


Figure 5- RIVERFRONT TYPES

#### A. Contemporary Type of Riverfront and Use

Contemporary things are modern and relate to the present time meant for the riverfront of present time along the use of modern type. In present time we use the riverfront area in type of-

- 1) Riverfront parks & ghats
- 2) Heritage and cultural zones
- 3) Resorts, farms, residential use
- 4) Wildlife sanctuary and eco village

And others depends on use and zones

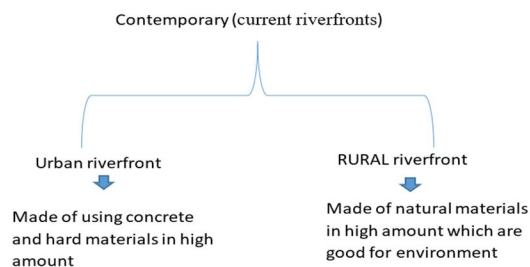


Figure 6- Urban Riverfront



Figure 7- Rural Riverfront

(Riverlife)

**B. In Contemporary Type**

- 1) *Urban Riverfront:* Concretization of built up (structure made of using concrete) & hard materials are use in bulk amount.
- 2) *Rural Riverfront:* Made of using natural materials most of time and ecofriendly design should be take for riverfronts. Also good for other lands like farming.

Water as a planning element and its effect in urban area

Due to flood danger by splitting water from watercourse, the watercourse shut was clearly unsettlement. we've to remain in our mind that riverscape has its own morphology. it is vital faith religion in morphology whereas exploitation these things of land. to travel into deep data, we've to discussion every a region of origin unsettlement riverscape. there is a watercourse terrace, flooding area (glay), distributed vegetation, periodical pools, flooding plain forest, periodical shoulder of watercourse, alluvium, piece of watercourse, mixture wall. it's clearly useful, if riverscape is semiconductor unit to be unsettlement. Ideal use for such a landscape is let's imagine park, urban park let's say} very case of town or city. These unsettlement places area unit clearly really precious among the city and is have to be compelled to be compelled to be used as a recreation or public space.

**IV. WATERFRONT AREAS AS A RECREATIONAL OR PUBLIC SPACE:**

- 1) Promotes communication between humans or human gathering and social activities.
- 2) Has style vouge and architectural design options that are attention-grabbing visually.
- 3) Promotes involvement of communities.
- 4) Present the native culture of region and history of that region.
- 5) Promotes a particular features or special character



Figure 8- River Scape

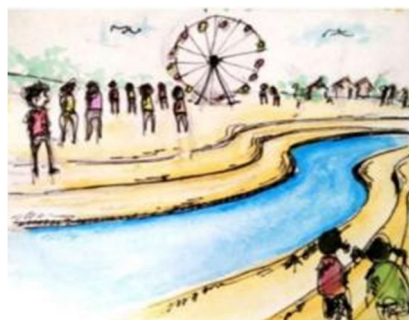


Figure 9- Recreation Activity

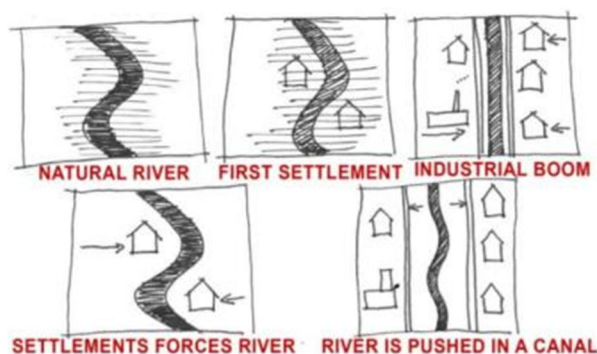


Figure 10- River Type & Settlements

**A. Type of Design Processes in Riverbeds and Riverside**

- 1) *Temporary flow Inconstancy*
  - a) *Sub Process 1:* Fluctuation of water level in vertical graph
  - b) *Sub Process 2:* lateral unfold of the water

2) *Morphodynamical Strategies*

a) *Sub Process 1:* geological phenomenon shifts beyond the stream of river water course

b) *Sub Process 2:* Auto-dynamic river watercourse channel-built development

3) *Limits in Springing up in Designing of Riverscapes*

a) Geographical nation or state network generally

b) Flood limitation

c) Limit of Auto-dynamic river channelization or watercourse development

d) Limit of controllability of river processes

e) Structural and vegetative diversity on riversides

4) *Basic Potential of Rivers in Urban Areas*

a) to provide some meeting functions in natural shut atmosphere

b) place to seem at natural processes

c) negative barrier in consistence in city or town

d) veins for transport

e) creator of microclimate in city or town

f) substance that brings smell and voice to environment

We have got to appreciate, that water is that the main attractive element in such as in surroundings or environment of the city or town, it's very important to allow citizens to travel nearer to the river, as it's potential.

*B. Principles of Approach in Making of Riversides*

How to enable people to travel nearer to river

1) A Larger intermediate level of bankside provides areas for lingering along the bank and temporary uses eg. Green belt zone

2) A staged circulation to the water over several large terraces allows some uses to exist

3) Broad bank steps turn out public spaces beside the water, providing direct connection with the river at several water levels

4) Wherever the riverside wall is broken at one purpose an area to linger at the bank can be created

5) A gap to the watercourse at certain angle or distance to the riverbank or riverbeds is that the special counter – construct to access along parallel

6) Gap in high flood solid protection walls may produces direct access to spaces that are subjected to flooding

7) By purring in removable flood barriers or windows flaps, sightlines and visual connections to river or watercourse may be preserved or maintained

8) Balconies project at specific places or distances along the river space or area and invite people to linger by the river

9) Boulders and stepping stones that rise higher than the mean water level enhances the experience of flowing water by creating direct contact attainable

10) On riverbank promenades that area usually flooded, stable foundation and also the selection of exceptionally heavy or serious or flood-resistance material for the furnishings and fittings are necessary (VIDROHI, 2019)

11) Planting in an exceedingly river's flood area at the foot of the bank wall will enhance the area significantly - floating islands open up areas that were antecedently inaccessible (Aherrao, 2019)

**V. URBAN & RURAL AREAS RIVERFRONT AND SEVERAL BODIES FOR GUIDELINES**

For any typology of riverfront like forest resort, eco village other tourist interaction project, farming, water channelization, dam and restoration of river work are including.

*A. Some Authorities who Handle Riverfronts*

1) Central Pollution Control Board (Ministry of Environment, Forest and Climate Change, Govt. of India (for restoration and cleaning purposes)

2) Government of India Ministry of Water Resources, River Development and Ganga Rejuvenation (guidelines for repair, restoration & renovation)

3) Central Water Commission (MOWR)

*B. Above Authorities Should Provide the Guidelines for*

- 1) Restoration of river
- 2) Cleaning & water channelization(dam)
- 3) Energy regeneration
- 4) Canal and farming uses

Some authority’s guidelines & their role

Various act, rule, policy & guidelines	Their meaning, role and government body.
Environmental protection act 1986 (india code, 2021)	The Constitution of India also provides for the protection of the environment. Article 48A of the constitution and Article 51 A further specifies that every people has to save and protect the environment. Defines that the State can attempt to protect and secure or improve the environment of the state area and to safeguard the forest existed and wildlife of the country. (india code, 2021) (mukhati, 2019)
Guidelines for the proposal of Urban River Management Plan for all Class II Towns in Ganga/Narmada River Basin 2010 (mukhati, 2019)	<ol style="list-style-type: none"> <li>1. Removal of encroachments from the land of riverfront and land acquisition or authority should cover it for riverbank development and beautification and along proposed development works.</li> <li>2. Restriction/banning of certain activities on the riverbank or in the river, viz., open defecation, disposal of solid waste, washing of clothes, wallowing of cattle, throwing of floral offerings, disposal of corpses, routine bathing (as opposed to ritual bathing), etc. (mukhati, 2019)</li> <li>3. Development/restoration of the riverbank area, i.e., construction / restoration of ghats, provision of public baths and toilets, construction of walkways, parks, other public spaces, access roads, commercial establishments, etc. (mukhati, 2019)</li> </ol>
Riverfront guidelines by MOEF	Type a – zone improvement plans (adp) would Apply to sub-projects where bigger waterway front Stretches say 1-2 km long and 30-40 m wide are Involved. Exteriors of riverfront advancement works should be coordinate past the social, strict and legacy slants and estimation of That specific spot or district. Giving the wandering trademark and kind of utilization Of most waterways, one of the fundamental prerequisites can be the accessibility of water along the riverfront banks round the year. (mukhati, 2019)
Biological Diversity Act, 2002	Article 48A of the order standards of state strategy announces: "the State will attempt to ensure and improve the climate what's more, to protect the timberlands and untamed life of the country". (Aherrao, 2019) 'Basic Duties' as conceived in Article 51A (g), forces a comparable obligation on each resident 'to secure and improve the regular habitat including backwoods, lakes, streams and untamed life what's more, to have empathy for living animals. (mukhati, 2019)
National green tribunal act 2010	Order of the National Green Tribunal (Central Zonal Bench, Bhopal) in the matter of Paryavaran Avam Manav Sanrakshan Samiti Vs. State of Madhya Pradesh & Others dated 09/04/2015 regarding construction near Narmada River with respect to No Construction Zone and the 30-meter Zone. National Green Tribunal on Friday provided the ban on sand mining and other illegals works from the rivers in Madhya Pradesh. (mukhati, 2019)
Madhya Pradesh Special Project & Township (Development, Regulation & Control) Rules, 2011	Development on waterway 10-20m from Rivers or lakes/lakes/repositories or nalas/trench or flood influenced territories
Water (prevention and control of pollution)1974 (WPC, 2008)	The demonstration has the point of forestall and control water contamination and deal with the nature of water and keep up or reestablish healthiness of water by setting up focal and state contamination control board to screen and implement the guidelines. (WPC, 2008)

Various act, rule, policy & guidelines	Their meaning, role and government body.
A Guide to Riverfront Development Connecting communities to the water SMARTNET.NIUA-Riverbanks, shorelines, riparian buffers, and river habitat is critically important when planning any riverfront project. (Riverlife)	<p>The riparian cushion ought to be no under 10-20 meter at its tightest, with three zones of cushion from the stream edge inland.</p> <p>Give a base walkway width of 10-15 feet for opposite associations Associations ought to be open to the public in any event, when they are neighboring private turn of events. Riverfront trails ought to be basic and incorporated with the scene and characterized by the vegetation of the recreation center. Promenades ought to be 15-20 feet and alongside 3-5 feet tree range, a riverfront park ought to be viewed as a feature of the recreation center.</p> <ul style="list-style-type: none"> <li>· Retaining divider must be.5-1metre of width alongside promenade of 5-10metre</li> <li>· Perpendicular Connections-Provide a base walkway width of 12 feet for opposite associations with be kept up as an easement or public option to proceed. Give a base misfortune to all designs, including wall, of 10 feet on one or the other side of the association</li> </ul>
Narmada valley development authority of MP	<ul style="list-style-type: none"> <li>• to bear obligation of human resettlement and restoration in regard of activities in the Narmada Valley, to set up towns and towns and - to take all important measures to guarantee arranged settlement and recovery;</li> <li>• to inform for the appropriate preservation regarding backwoods and improvement of woods, natural life and fisheries in the Narmada Valley;</li> <li>• to secure and oversee land in the Narmada Valley to complete designing works, to accommodate human.</li> <li>• no development must be done 10-15 from the edges of Narmada waterway (Riverlife)</li> </ul>
<b>BUILDING BYE LAWS (ZONAL OR ARIAL DIVISION)</b>	<p>Area has authority to control the construction type and development Provides laws to follows in planning and design then construction of building of any area. e.g., Lucknow development authority and building bye laws 2008</p> <ul style="list-style-type: none"> <li>• Rural area follows the law of their state or nearby development authorities for any kind of built up.</li> </ul>
Bureau of Indian standards (the national building codes)	The National Building Code of India (NBC), a comprehensive building Code, is a national instrument providing guidelines for regulating the building construction activities across the country.
Soil and Water Conservation   National Portal of India	Provides the data of soil testing and water quantity for design accordingly.
URDPFI (MINISTRY OF HOUSING AND URBAN AFFAIRS)	Urban and Regional Development Plan formulation and Implementation – 2014 is modified and upgraded version UDPFI Guidelines-1996 for framework for Urban Development and Plan formulation.

TABLE-1: Authorities/Guidelines And Their Roles  
Some authority’s guidelines & their role

1) *Environment (Prevention & Protection) Act, 1986*: This is umbrella Act given by government underneath that all the Acts and Rules are outlined along with both Air and Water Act. This Act was passed as a general exhaustive demonstration "for security and improvement of climate". Predictable with this Act, the Central Government has the office to take every such measure, since it considered significant or convenient to ensure and improving the nature of climate or air of earth and forestalling, controlling and lessening ecological contamination. Under this Act, (AGARWAL, 2018)decides are with the end goal that predetermined for release/emanation of effluents and entirely unexpected principles for ecological quality. These incorporate Ambient Noise Standard, Emission from Motor Vehicles, and Mass Emission Standard for Petrol Driven Vehicles, General Effluent Standards and so forth particularly significant for street project. (india code, 2021) (AGARWAL, 2018)



- 2) *Forest (Conservation) Act, 1980*: According to Section (26) of Indian Forest Act, 1927 assortment of exercises are denied in woodland territories and past endorsement is required from the focal government to utilize timberland land for non-backwoods capacities (AGARWAL, 2018). (mukhati, 2019) The Forest (Conservation) Act, 1980 disallows enormous scope redirection of forestland for non-woodland use. As changed in 1988, no Government or authority will construct such redirections besides with the earlier endorsement of the Central Government or State Government all things considered (india code, 2021)Woodland leeway under this demonstration isn't required because of no backwoods land redirection arranged or proposed, yet tree cutting consent has been taken from Forest office for tree felling inside the task region. (bio diversity of India 1980, 2003)
- 3) *Forest (Conservation) Rules, 2003*: According to Rule six (6) of the Forest (Conservation) Rules, 2003, every client organization, who wants to utilize any backwoods land for non-timberland uses and capacities, will assemble his proposition in Forms added there to it. Structure 'A' is required for proposition looking for beginning time endorsement underneath the Act (mukhati, 2019). Structure 'B' is required for proposition looking for restoration of leases any place endorsement of the Central Government underneath the Act had just been gotten before. The Act won't be material as there is no timberland land is worried inside the proposed or arranged venture (bio diversity of India 1980, 2003)
- 4) *Wild Life Protection Act, 1972*: Natural life Protection Act, 1972 This demonstration is distributed to supply for the assurance of untamed wild creatures, birds and plants and for issue associated immediately. The arrangements underneath this Act are as followed: Section nine (9) of the Act specifies that not every person will chase any wild creature according to Schedule. (bio diversity of India 1980, 2003) (india code, 2021)
  - a) The Act forbids picking, removing, harming, annihilating, exertion any nominative plant from any forestland. (mukhati, 2019)
  - b) It boycotts the work of harmful substances, synthetics, unstable which will cause injury or imperil untamed life in an extremely asylum. No change of the limits of a National Park will be make besides on a goal passed by the overall gathering of State. Obliteration or injury of natural life property in a National Park is denied. (india code, 2021)

There are no biologically touchy areas, for example, National Park, Wildlife Sanctuaries or Biosphere Reserve are settled at stretches inside 10 km distance from the undertaking site.

- 5) *The Water (Prevention and Control of Pollution) Act, 1974*: Water Act is that the first ecological guideline that was presented at the State and Center levels, Pollution the executives Boards to direct/manage natural contamination in Republic of India. Changed twofold in 1978 and 1988, the Act vests administrative office on the State Pollution the executives Boards and enables them to decide and authorize emanating guidelines for enterprises and local specialists releasing effluents (mukhati, 2019). The Act came about inside the establishment of the Central and State Level Pollution Management Boards whose obligations embrace overseeing water quality and profluent guidelines, besides as watching water quality, indicting guilty parties and issuance licenses for development and activity of bound offices. The Act engages the board to exact and gather cess on water devoured by the business or authority and to use and expand assets for the Pollution the executives Boards. In accordance with this arrangement, The Water (Prevention and the executives of Pollution) Rules, 1975 were created. The task needs Consent to decide from the UP-State Pollution control board underneath Water (Prevention and the executives of Pollution) Act of 1974. (WPC, 2008) (bio diversity of India 1980, 2003)
- 6) *Construction & Demolition Rule, 2016*: The principles will apply to each waste resulting from development, re-displaying, fix and destruction of any respectful design of individual or association or authority that produces development and destruction squander like structure materials, trash, rubble. each waste generator will at first sight be chargeable for collection, isolation of solid, soil et al and capacity of development and destruction squander created, as coordinated or (INDIA, 2016). waste produced all through development exercises worried in present undertaking.
- 7) *Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016*: These guidelines will apply to the administration of hazardous and elective squanders according to the Schedules to those principles anyway will not matter to- (WPC, 2008)
  - a) Waste and fumes gases as lined underneath the arrangements of the Water (Prevention and the executives of Pollution) Act, 1974 (6 of 1974) and furthermore the Air (Prevention and the board of Pollution) Act, 1981 (14 of 1981) and furthermore the standards made under it and as changed now and again; (india, 1981) (bio diversity of India 1980, 2003)

**VI. DIFFERENCE BETWEEN URBAN & RURAL RIVERFRONT AREA**

Terms	Urban area	Rural area
Aim	In urban area riverfront development happening in the context of ENVIRONMENTALLY FRIENDLY having most of the focus on green area e.g., parks	In rural area riverfront development happening in the context of Architectural and tourism to represent the culture of that area and economic growth. E.g., eco resort.
Main objects	<ul style="list-style-type: none"> <li>To develop green zones for urban community.</li> <li>Water quality improvement of river</li> <li>Tourism and economic growth</li> <li>Identity to urban area</li> <li>flood mitigation works</li> <li>recreational improvement</li> <li>public space creation</li> <li>slum recovery works</li> <li>groundwater re-energize</li> <li>infrastructure improvement</li> </ul>	<ul style="list-style-type: none"> <li>Tourism impact increasement</li> <li>Develop architectural good</li> <li>Identity to rural area</li> <li>Employment generates</li> <li>Water quality good</li> <li>Flood</li> <li>Easy water access to fields</li> <li>Farming initiation</li> </ul>
Guidelines follows	<p>For building and hard built-</p> <ul style="list-style-type: none"> <li>Bye laws of development authority</li> <li>Architectural standards</li> <li>National building codes and other</li> </ul> <p>For riverbed areas and riverfront</p> <ul style="list-style-type: none"> <li>Ministry of irrigation and resources for flood mitigation</li> <li>Environmental protection act</li> <li>Riverfront guidelines from particular department and Indian standards</li> </ul>	<p>For building and hard built-</p> <ul style="list-style-type: none"> <li>no local bye laws available uses nearby authority or Indian standards (most of time not follows )</li> </ul> <p>For riverfront</p> <ul style="list-style-type: none"> <li>Last year records for floods mitigations</li> <li>And others Indian level standards.</li> </ul>

TABLE-2: Difference between urban & rural riverfront area

**VII. CHAPTER-3 CASE STUDY**

**A. Sabarmati Riverfront Development: Ahmedabad**

- 1) *Introduction:* The Sabarmati River Front Development Corporation Limited (SRFDCL) is established in 1997 for the development of the riverfront in the city. KPMG (Klynveld Peat Marwick Goerdeler), the firm who's counts in one of the top firm their Sabarmati Riverfront Development Project in '100 most Innovative Projects' in the field of urban regeneration (2012) that make cities liveable as well as sustainable (bhatt, 2017). The project consists both banks of the Sabarmati designed for a 10.5 km stretch, developing approximately 202 hectares of reclaimed land. There is a system for water management and flood control to minimize the flood and clean up the river water with new sewage treatment infrastructure to enhance the water quality. (DEVELOPMENT S. R., 2021)
- 2) *Need Of Riverfront Development*
  - a) The escalated uses or need negatively affected the waterway and riverbed.
  - b) Untreated biodegradable contamination or sewage streamed into the conduit through storm water outfalls and unloading of mechanical waste represented a critical wellbeing and ecological peril (bhatt, 2017)
  - c) The stream bank settlements were lamentably in danger of floods and needed fundamental framework offices. Dull advancement took structure on the riverfront. Such conditions made the stream conduit unavailable and it turned into a virtual split between the two number of parts of the metropolitan city. (DEVELOPMENT S. R., 2021)



## Original condition of the river near Vadaj

Figure 11- Condition Of River In Past



Figure 12- River Bed In Dry Situation

### 3) *Project's Main Objectives*

- a) The project just points are furnish Ahmedabad with a characterizing waterfront climate along the two banks of the Sabarmati River and to rethink a picture of Ahmedabad along the stream. The task attempted to reconnect the city with the waterway and emphatically change the ignored parts of the riverfront. (Improvement S. R., 2021)
- b) The destinations of this task can be characterized under three points
- c) Environmental Improvement: decrease in disintegration and flood to defend the city; sewage or waste material redirection to scour or clean the stream; water maintenance and re-energize.
- d) Social Infrastructure: restoration and transplantation of riverbed tenants and exercises; formation of sporting parks, ghats and public spaces; arrangement of socio-social conveniences for the city.
- e) Manageable Development: age of assets, improvement of neighborhood

4) *Features Of Sabarmati Riverfront Development*

- a) The decrease of the riverbed from a variable dimensional width of 600-300 m to a fix measurement width of 275 m, in this way recovering 185 ha of land.
- b) The development of RCC stomach dividers (10-20 m profundity) and anchor sections (10 m) to prevent the riverbanks from disintegration. when the completing the anchor chunk block is turned inside the supposed lower promenade.
- c) The development of interceptor sewers on both the riverbanks ready to forestall the waste water to stream straightforwardly into the waterway and redirecting it to the two sewage treatment plants of vasna and pirana.
- d) The development of RCC holding dividers (2.5 - 9 m) as a protect the city from flooding. The tallness of the dividers is set by the 100-year flood level. A higher promenade is framed on top of the holding dividers. (DEVELOPMENT S. R., 2021)

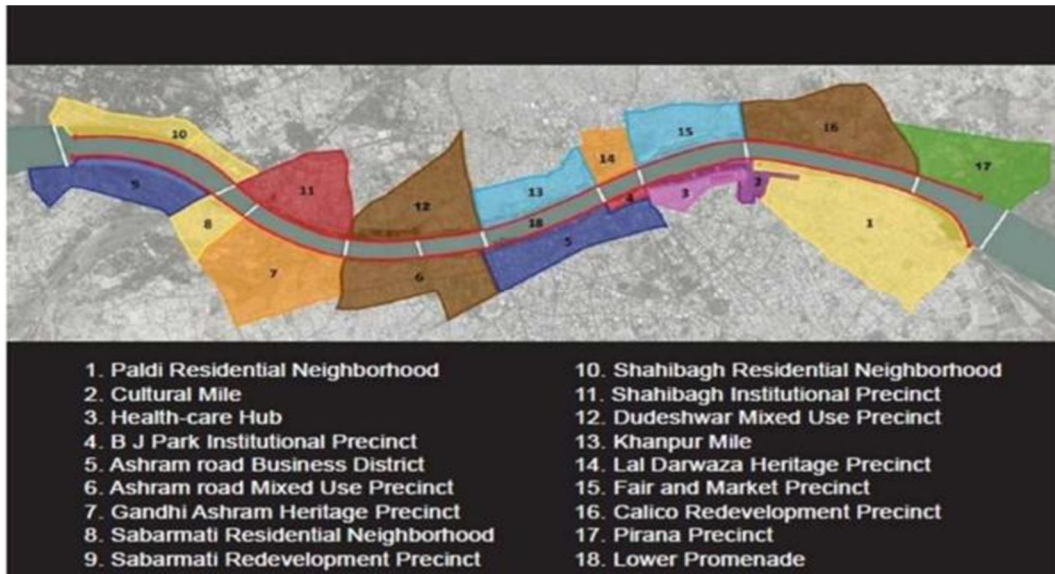


Figure 13- Sabarmati Riverfront Land Use

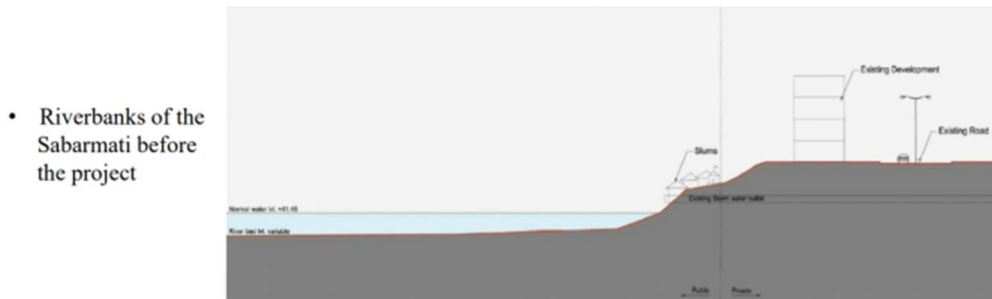


Figure 14- Riverbed Sectional View Before

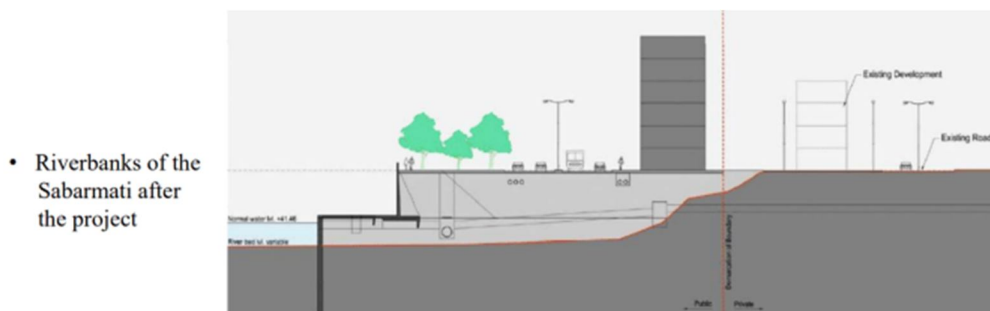


Figure 15- Riverbed Sectional View After



**B. Riverfront Land Use**

The proposed development is of mix land use that includes commercial, recreational and residential developments within the both side of river bank from Gandhi Bridge to Sardar Bridge.

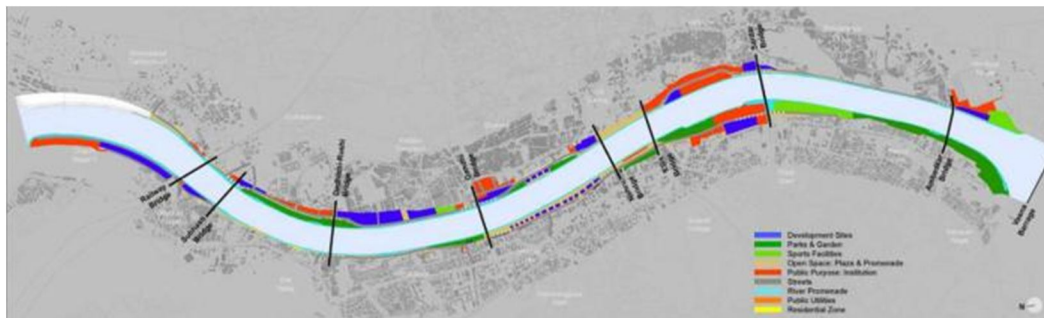


Figure 16- Sabarmati Riverfront Land use Type

Sr. No.	Sanctioned Land Use	Area Sq. m.	Area Ha.	%
1	Road	4,44,378	44	22
2.	Garden	2,74,585	27	14
3.	Open space	3,71,198	37	18
4.	Public purpose	2,88,875	29	14
5.	Lower Promenade	2,66,462	27	13
6.	Multi use for sale	2,94,083	29	14
7.	Sports	72,503	7	4
8.	Residual ( Utilities, Residential, Commercial, General, Education)	15,787	2	1
	Total	20,27,871	202.8	

(Source- <http://www.sabarmatiriverfront.com>)

Figure 17-Legends

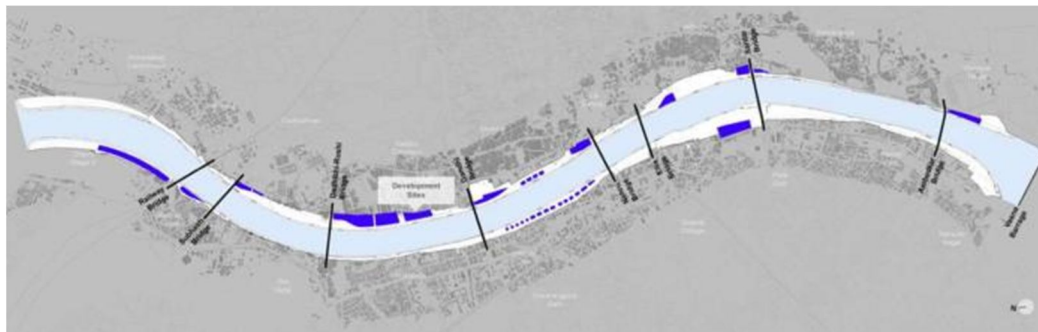


Figure 18- Development Sites



Figure 19- Amenities Area



### 3) *Impact Of Sabarmati Riverfront On The Built Environment Along The River*

#### a) *Physical*

- The land value increases up to 5-10 km area of both side of riverfront.
- Societies connection increases on that area.
- Peoples are attracting to that place and organising cultural events.
- Tourism increases, employment generate.

#### b) *Architectural*

- The built environment along the riverfront are following the theme of modern architecture along with local cultural architecture of that place. (DEVELOPMENT S. R., 2021)
- Also, peoples are taking interest to built something good for attraction along with riverfront. Example- hotels with riverfront view, restaurent, malls, cinema, official buildings, g+5 above buildings. (DEVELOPMENT S. R., 2021)

#### c) *Environmental*

- The environment of that place becomes good
- Green belt with green area increses
- Plantation generates
- Water quality improved

### C. *Yamuna Riverfront Development*

River Yamuna is the fifth longest river in India and forms the largest tributary Of the Ganges The river cognates from Champasar lake in Bandar pooch Glacier in Uttarakhand The river flows through snow-capped Himalaya before entering the Ind-Gangetic plains of North-India After travelling for 1376 km the river finally merges onto River Ganga at Allahabad. (DEVELOPMENT Y. , 2018)

Delhi has been site for a few realms inferable from closeness of Yamuna waterway. Recorded landmarks in metropolitan place are powerful confirmations of relationship of the waterway and thusly the city. Be it the situation of the Feroj Shah Kotia'sfort or the presence of the Red post right close to the waterway all through Shahjahan's rule shows the significance of the stream inside the city's set of experiences. (DEVELOPMENT Y. , 2018)

1) *Evolution of the River:* The waterway pass a piece of Indus River framework at first. Over the long haul its course moved and it became buddy of the Gaga River framework streaming over the Aravalli. This move in course diode to development of a triangle with edge on different sides( Aravalli) and furthermore the waterway flood plats on the third The landform was smell rough piece of territory With time. Early settlements settled along the water sources and dependent on the land accessibility dependent on adjusted asset utilization the streams and other water sources chose the example of the settlements Open zone like nurseries parks were basically arranged past settlement dividers. Early frontier settlement came up along the North of the walled city and the edge went about as a cradle between the walled city. New terrains were analyzed to grow. (WPC, 2008)The course of the stream was more modified by building dikes and the space was safeguarded for improvement The underacted as a city's backwoods cover and the waterway provided the city with water The open spaces in the long run became formalized and the street network was arrangement for the development of vehicles. The waterway and the water streams became characteristic waste framework for the city Independence development influenced territories beside that were underneath supreme control by the executives.. (DEVELOPMENT Y. , 2018) (DEVELOPMENT R. , 2020)

2) *Aim:* To moderate the stream, secure and reestablish the climate or Biodiversity of Yamuna River by Public Recreation spaces in the greater part of the region in Delhi.

3) *Objective:* Restore the riverine ecosystem

- a) Connect people with river
- b) Protect the floodplain from the adverse effect of development activities
- c) Share awareness among people

#### 4) *The Structure Plan*

The floodplain has been studied & analyzed based on several ecological & physical parameters, such as -

- a) Natural features already existed like water bodies, trees, mounds and paths vegetation, etc.,
- b) Proximity to habitation & movement corridors,
- c) Intensity & conformity of abutting activities. (prashant, 2016)



- 5) Zone
  - a) Interactive Biodiversity Zone
  - b) Protective Biodiversity Zone
  - c) Public Recreational Zone

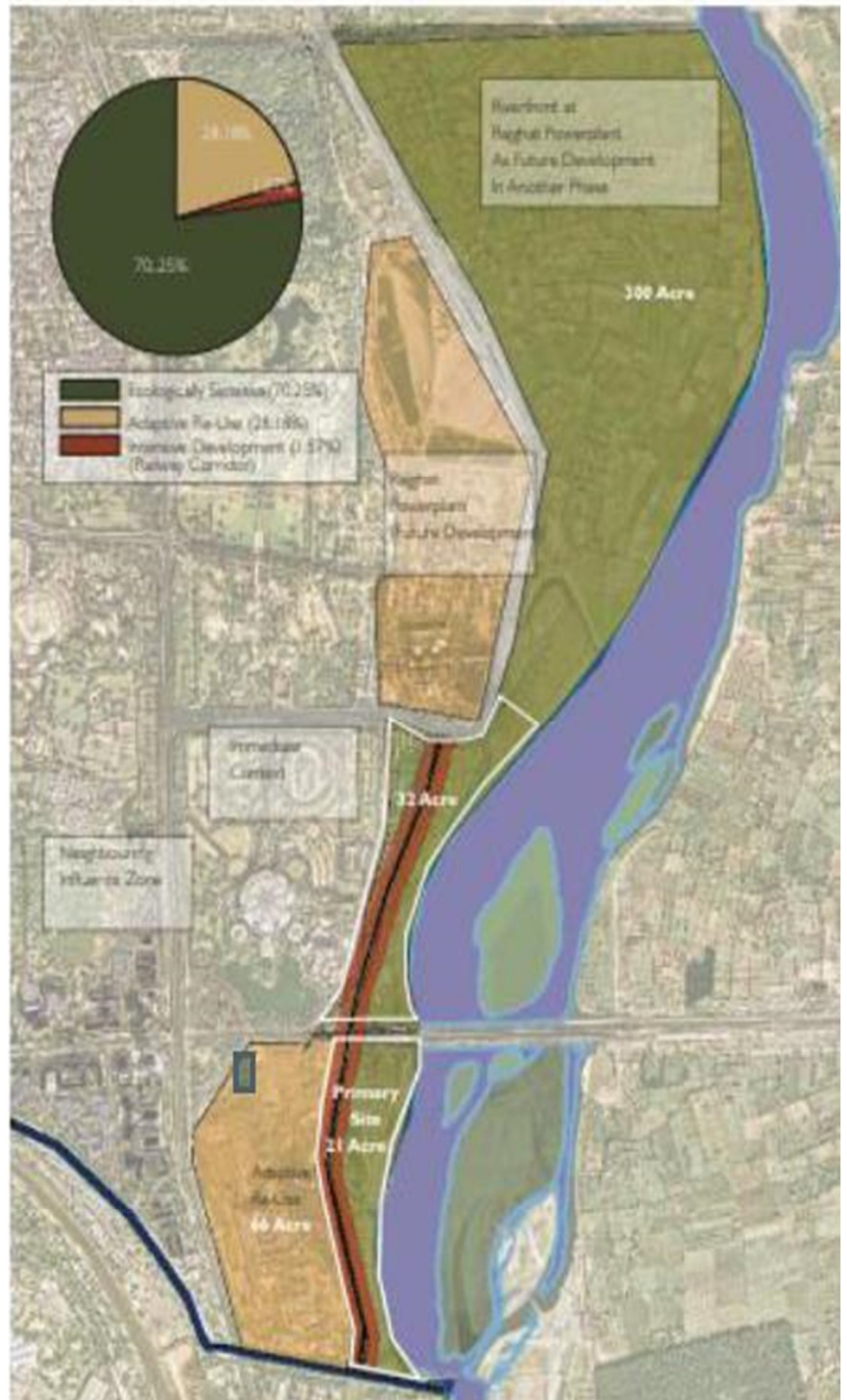
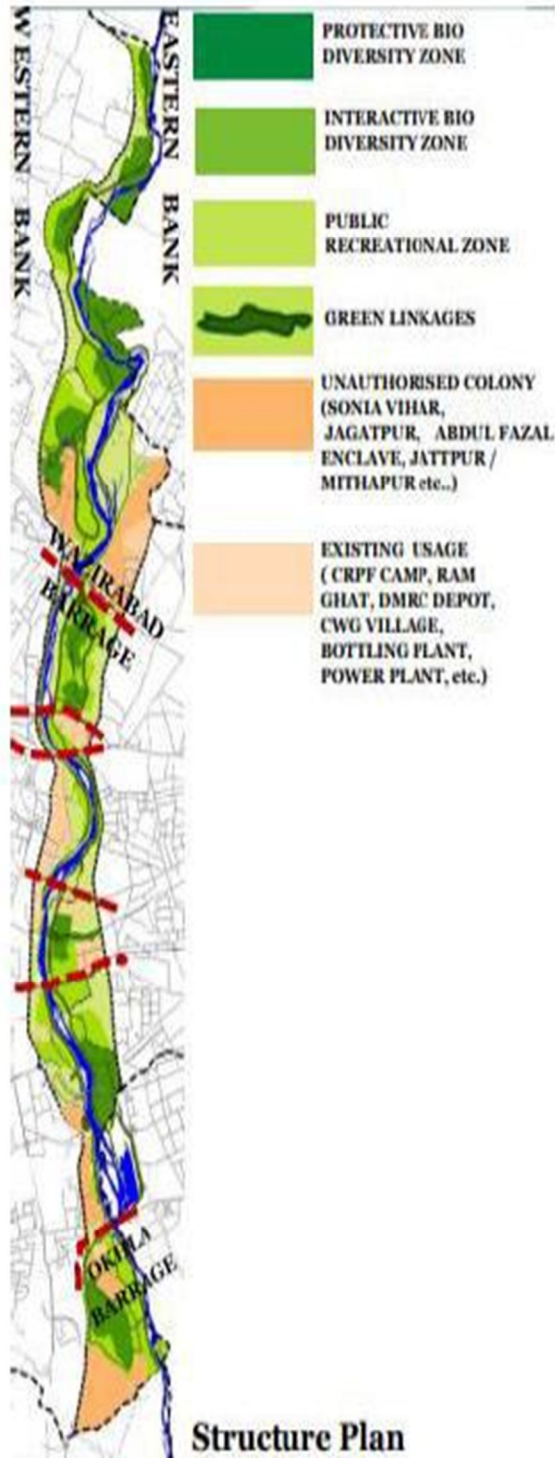


Figure 22- Landuse At Yamuna Riverfront



**D. River Yamuna –In Delhi**

The old Delhi stretch of River Yamuna is scarcely 22 kms of its whole 1,370-km long excursion from Yamunotri, Uttarakhand (its origination) to the sea. despite the fact that scarcely a couple of 2% of the length of the geographic locale of the waterway bowl, it adds to more than 80% of the contamination load inside the whole stretch of the conduit. There is no water inside the waterway for pretty much nine (9) months of the year. old Delhi seizes water at Riverfront Development.

•The torrent developed at Wazirabad, where the waterway enters inside the city. Which lows in the waterway hence is just sewage and waste materials from Delhi in 22 channels. (DEVELOPMENT Y. , 2018) (BASIN, 2018)



Wazirabad Barrage



ITO Barrage



Okhla Barrage

Figure 20-Yamuna Riverfront Strip Figure 21-Condition And Situation Of Yamuna (WPC, 2008)

The site keeps on having recorded, archaeological, field of study and imaginative worth in light of the fact that the dividers of the vestiges converge with the more current developments around. The significance of this site, must to be ensured, safeguarded and expanded for the aptitude of people who visit or live in Delhi. The constituent constructions hold the possibility to proceed with the principal plan goal or suggest intercessions for versatile use or new use, therefore reestablishing the social pertinence of the siting of site, while making it a zone for individuals to appreciate and information their own legacy. (DEVELOPMENT Y. , 2018) (BASIN, 2018)

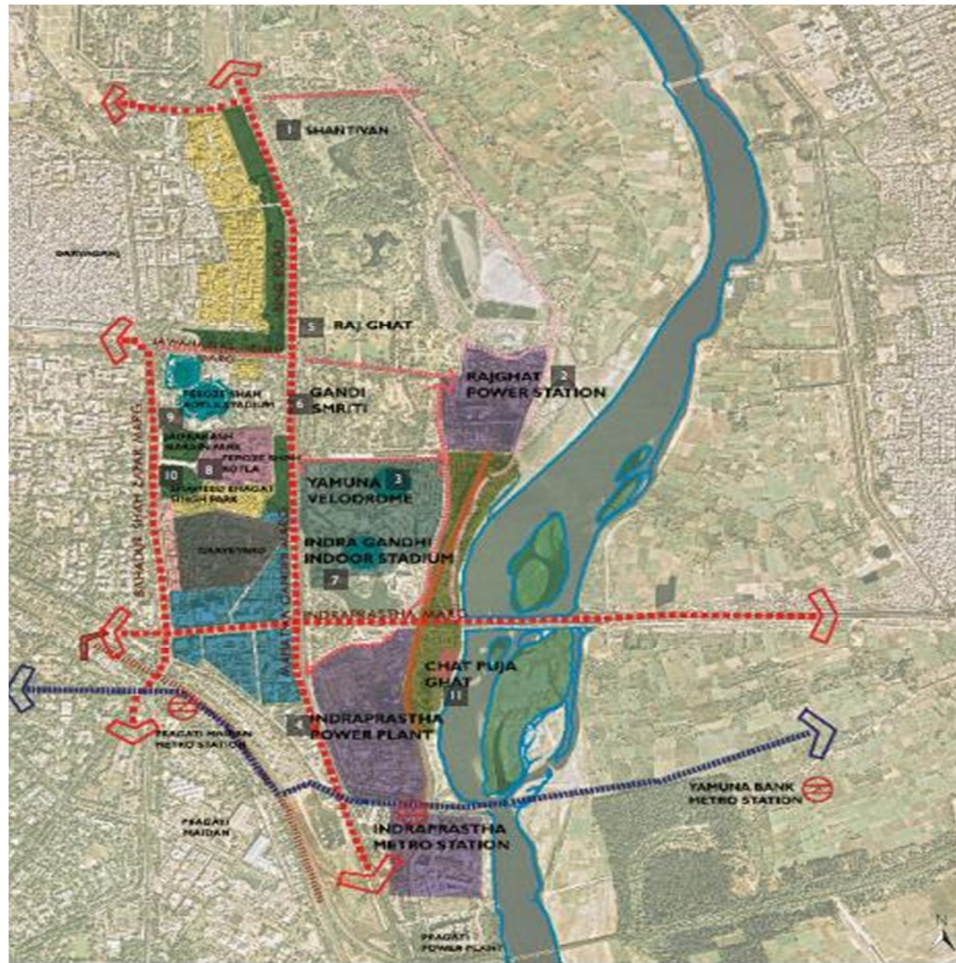


Figure 22- Yamuna Landuse At Wazirabad



The site precinct has number of mixed-uses. The predominant ones being professional institutes and offices. It has numerous nationally significant monuments (Refer Annexure) located in close proximity. Four major sports activity buildings, namely IG Indoor Stadium, Yamuna Velodrome, Feroz Shah Kotla Stadium and Ambedkar Stadium. Two parks – Shaheed Bhagat Singh Park and Jai Prakash Narayan Park. Two major power stations, Rajghat Power Plant and Indraprastha Power Plant, and historically significant monuments Feroz Shah Kotla and Khooni Darwaza. As such there is no residential area in the site precinct other than Vinod Nagar located close to the Feroz Shah Monument. Daryaganj, one of the oldest residential areas of the city, is located nearby but is not part of the study area.

Figure 23-LEGENDS





Figure 24- Proposal Yamuna Riverfront

*E. Features of the Riverfront Development Plan of YAMUNA (DUAC)*

- 1) Adaptive re-use of commercial and industrial buildings (IP Power Station) and railway line.
- 2) Restoring ecology and rising water quality.
- 3) Planting native species along the river corridor.
- 4) Accommodating the street vendors at ITO bridge into the weekly haat\_ making plazas and exhibition areas to draw in tourists.
- 5) Produce a bird watch zone which can be landscape therefore on attract migratory birds to the positioning site.
- 6) Solar Park: Adaptive re-use of existing grid and turning it to an influence power generator.
- 7) Utilizing Secretariat and Indira Gandhi Stadium's parking for parking requirements the planned site.
- 8) Improve accessibility to the positioning site keeping in mind the exercise of sustainable modes of transport including walking and cycling athletics.
- 9) Providing resting area at regular distances along the pedestrian path give shaded pathways and correct street piece of furniture
- 10) A visible link furthermore as pedestrian link from the traditionally vital monuments(like FerozShah Katie) is to be created
- 11) Water bodies except for the river and therefore the Nullah which is present on site. a pond is planned in the broad walk area and therefore the train entrance plaza A water fountain is planned at youngsters or children's activity zone
- 12) Chhatt Pula is widely known on the banks of the every year. Thousands of individuals returned to the river and provide their prayers to the Sun God. The arrange aims at providing parking area and planning a large pen area to accommodate people once the event takes place. It conjointly aims at providing temporary shelter because the people tend to remain overnight. (YAMUNA, 2018)

<p><b>YAMUNA RIVERFRONT</b></p>	<ul style="list-style-type: none"> <li>• Planting native Species along the river corridor.</li> <li>• Restoring ecology and improving water quality</li> <li>• Create a bird watch zone which will be landscaped as to attract migratory birds to the site.</li> <li>• Adaptive rescue of industrial building (IP Power station) and railway line</li> </ul>	<p>Utilizing secretariat and Indira Gandhi Stadium's parking requirement of the site.</p> <ul style="list-style-type: none"> <li>• Improve accessibility to the site keeping in mind the utilization of sustainable modes of transport including walking &amp; cycling.</li> <li>• Provide resting space at regular intervals along pedestrian path. Provide shaded pathways and proper street furniture.</li> <li>• A visual link as well as pedestrian link from historically significant monuments like (Firoz Shah Kotla) is to be created.</li> </ul>	<ul style="list-style-type: none"> <li>• Accommodating the street vendors at ITO bridge into weekly haat.</li> <li>• Creating plaza and exhibition space to attract tourists.</li> </ul>
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Figure 25-Inferences From Riverfront

*F. Tentative Program Activities And Use*

- 1) Development of ghats along the stretch of Ganga.
  - 2) Promenades including -Kiosk (connecting ghatstogether) & Cycling Track Community & cultural centres
  - 3) Landscape work in the precinct zones
  - 4) City level parks
  - 5) Improvement of approach roads to the precinct.
  - 6) Art and craft village
  - 7) Boating Station
  - 8) Heritage Plaza
  - 9) Sports Activities
  - 10) Meditation or yoga centre
  - 11) Cafeteria
- Public toilets complex  
(YAMUNA, 2018)

**VIII. DATA ANALYSIS AND INFERENCES**

3 Cause And Defects In Present Riverfront Areas

DEFECTS	CAUSES	SABARMATI RIVERFRONT	YAMUNA RIVERFRONT
Water Quality And pollution	SEWORAGE DISCHARGE	(BOARD, 2019)This report is based on joint investigations, by Paryavaran Suraksha Samiti and Gujarat Pollution Control Board (GPCB), on the rising pollution in the river and discharge of industrial effluents and sewerage in the water. (WPC, 2008)	YAMUNA RIVERFRONT WATER QUALITY The water quality was good along areas where the river enters Delhi before the Wazirabad barrage. While the optimum pH for river water is around 7.4, the study found that Mean pH of the Yamuna water varies from 7.5 to 11.8 at different sampling points. (2016, 2016) (WPC, 2008)
ECOLOGICAL IMPACT	IN LESS AREA WHERE HIGH USE OF CONCRETE	GARBAGE COLLECT ALONG THE RIVERSIDE IN NON BUILT AREA OF RIVERFRONT (VIDROHI, 2019)	GARBAGE COLLECT ALONG THE RIVERSIDE IN NON BUILT AREA OF RIVERFRONT (VIDROHI, 2019)
BUILT UP CONTROL	TEMPORARY BUILT UP OF STALL AND TEMPORARY STRUCTURES	RENTAL BASIS BUT EFFECT THE ENVIRONMENT ALONG THE RIVERFRONT (author)	RENTAL BASIS BUT EFFECT THE ENVIRONMENT ALONG THE RIVERFRONT (author)
INFRASTRUCTURE QUALITY	UNNECESSARY DEVELOPING IN HEIGHTS	SHOULD BE RESTRICTED BY AUTHORITY BUT STILL GOING ON (author)	SHOULD BE RESTRICTED BY AUTHORITY BUT STILL GOING ON (author)
AMENITIES AND ACCESS	SOMETIMES CROWD AND HIGH TRAFFIC	CAUSE OF PRIMARY PATHS AND PARKING LOTS (author)	CAUSE OF PRIMARY PATHS AND PARKING LOTS (author)

Table-3: Cause And Defects In Present Riverfront Areas



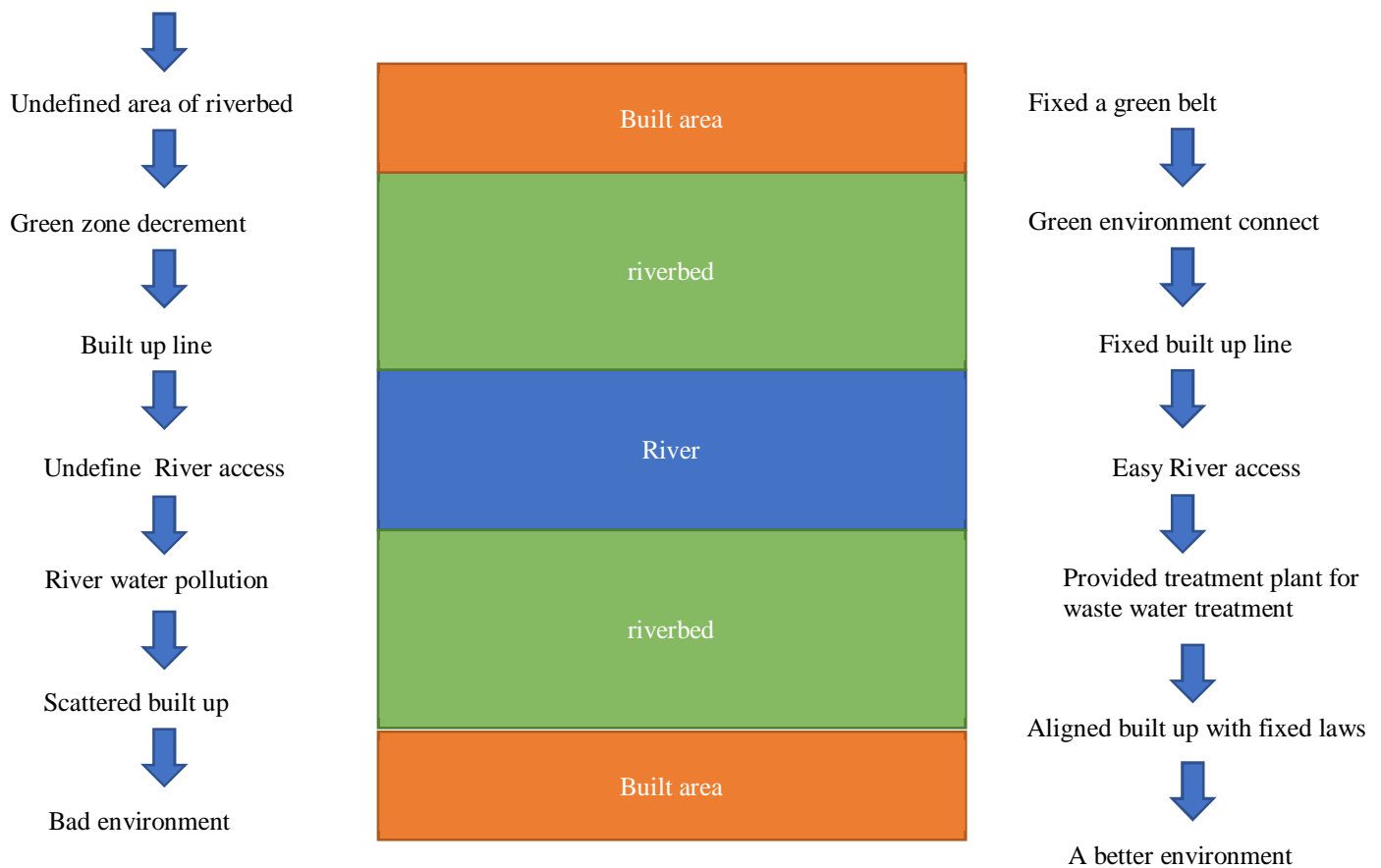
A. Inferences From Comparison

Inferences	Urban	Rural
Green belt formation and area zone	define way	Undefined way
Built area zone and belt	Define way from a distance from river	Undefined way Built along the river
Environmental analysis	Follows	Already when its forest area. In open field follows in less amount
Structural analysis	Follows then built for safety	In low amount
Water pollution	Controlled by provide treatment plants along river for sewer	Directly discharge in the river

TABLE-4: Inferences from comparison

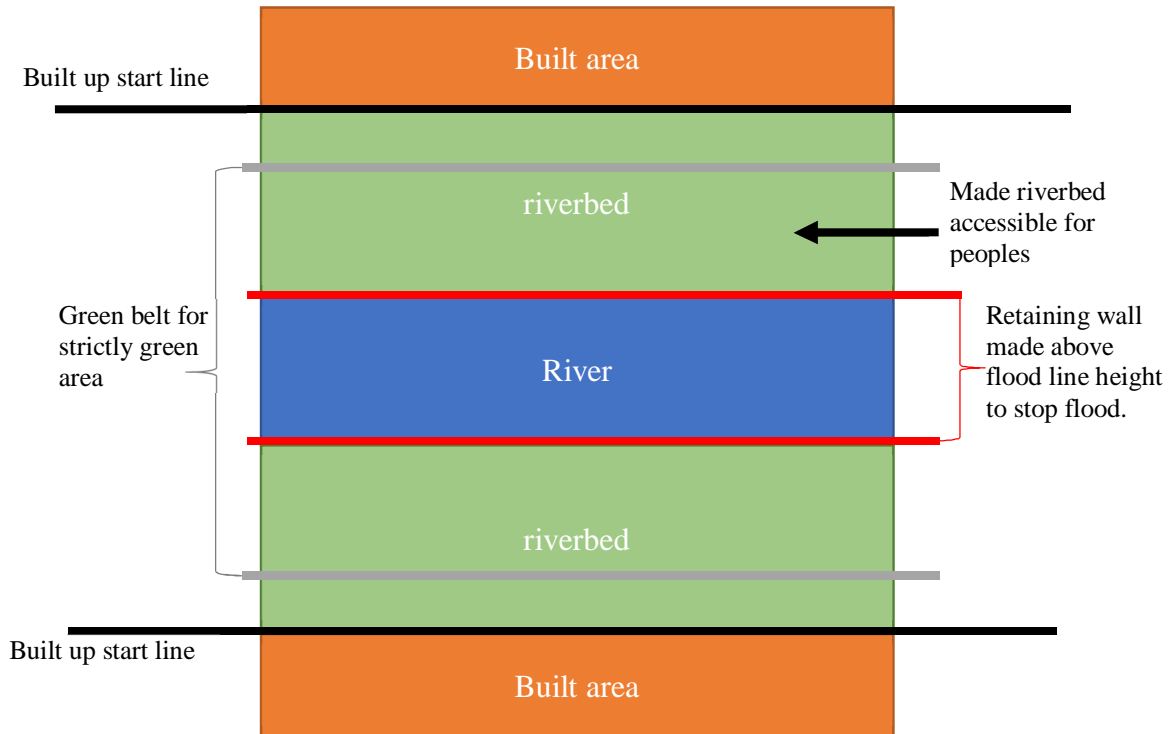
B. Strategy Follows in Design of Riverfront

On the riverbed-



C. Strategy Follows in Design of Riverfront

On the riverbed-



D. Strategy Follows In Design Of Built Area Along Riverfront

Parks	Residential	Commercial	Industrial
Provided green zone area on river bed from retaining wall to build up line	Building may construct after built up line	Building may construct after built up line	Construct outer zone of the urban area along river
Follows the act of <ul style="list-style-type: none"> <li>Environmental protection act</li> <li>Biological Diversity Act,2002</li> <li>National green tribunal act 2010</li> </ul>	Follows the acts- <ul style="list-style-type: none"> <li>Building bye laws of local authority</li> <li>URDPFI</li> <li>National building codes standards</li> </ul>	Follows the acts- <ul style="list-style-type: none"> <li>Building bye laws of local authority</li> <li>URDPFI</li> <li>National building codes standards</li> </ul>	Follows the acts- <ul style="list-style-type: none"> <li>Building bye laws of local authority</li> <li>URDPFI</li> <li>National building codes standards</li> </ul>
Socially connects and generate the economy	Shows the architecture of local or modern.	Shows the architecture of local or modern	Shows the architecture of industrialization.
Physical identity to the city	skyline along the river.	skyline along the river.	skyline along the river.
A healthy environment	A living environment	A economic environment	A employment and industrial environment

TABLE 5: Strategy follows in design of Built area along riverfront

**IX. CHAPTER -:INFERENCES & CONCLUSION**

**A. 4 Inferences**

**1) Major Point To Be Study In Riverbed Designing**

- a) Green belt formation and area zone
- b) Built area zone and belt
- c) Environmental analysis
- d) Structural analysis
- e) Water pollution
- f) Amenities and access
- g) Planting native species of trees and others along the river corridor
- h) Restoration of ecology
- i) Area specification and type of built up
- j) Socially connected and friendly
- k) Recreational activities
- l) Tourism attraction
- m) Easily accessible
- n) Pollution friendly (all kind of)

**2) Major Point To Be Study In Infrastructure Designing**

- a) Eco- friendly buildings and infrastructure
- b) Creating better and attractive environment
- c) Large capacity of green area and activities
- d) Recreation zones
- e) Building bye laws and guidelines
- f) Local architecture supportive
- g) Economically beneficial
- h) Tourist attractive
- i) Sewage treatments plant necessary to avoid the water pollution of river
- j) Pollution control equipment

**3) Different Acts And Policies Recommendation For Projects Of Riverfront Areas**

Act & policies	Term of riverfront	Term of architectural built up
Ministry of Water Resources, River Development and Ganga Rejuvenation (MOWR, 2016)	<ul style="list-style-type: none"> <li>• Provide analysis and data of water channelization in rivers</li> <li>• flood levels</li> <li>• restoration of rivers along the riverbed</li> <li>• Water quality</li> <li>• Reservoir</li> <li>• Mangroves</li> </ul>	Details about the riverbed retaining wall design and construction based on flood level. (no such data related to architectural design for buildings )
Central Water Commission	Provide data on river connectivity Dam construction	Dam and bridge development
The national building code (india code, 2021)	-----	Details for architectural planning & designing of spaces and buildings
Building bye laws	-----	Planning and design according to particular area and type in controlled built
Irrigation and Water Resource Department (INDIA, 2016)	Water flood management	Built up restriction in several area identification

TABLE 6: Different acts and policies recommendation for projects of riverfront areas



4) *Study Approach And Materials For Future Projects*

<ul style="list-style-type: none"> <li>• Master plan</li> <li>• Flood level guidelines</li> <li>• Water channelization data</li> <li>• Transportation and infrastructure mobility plan</li> <li>• Land use plan</li> <li>• Proposal understanding</li> <li>• Bye laws for built development</li> <li>• Acts to follows in development for particular design and area</li> <li>• Approval process from authority and panel</li> <li>• Construction approach</li> </ul>	<ul style="list-style-type: none"> <li>• Following already built projects strategy and concept ideas</li> <li>• Existing projects model work as self-guidelines</li> <li>• Built infrastructure follows same typology and phenomena</li> </ul>
---	--

5) *Some Objectives For Future Projects*

- a) Riverfront recreational design
- b) Access to Waterways
- c) Flood level mitigation
- d) Zone wise development
- e) Water quality analysis
- f)

The framework necessary for a better design of riverfront should have:

- Several exercises in a few zones on riverfront. All the areas of metropolitan exercises (financial beneficial, private, bearing on culture and recreation, versatility), ought to be appropriately blended.
- River front ought to be created by remembering some past and present uses for these zones with the point of keeping them alive in the memory of such remarkable viewpoints, and defensive old personality of those spots.
- A guide of street having all courses that encourage and create cooperation between various exercises as opposed to isolating them.
- The next to each other improvement of 'public and private' is alluding to capacities (government workplaces, exhibition halls and so forth), spaces (courts, streets, parks and so on) and the entertainers dealing with the administrations on the riverfront.

6) *Site Recommendation*

This study should be applicable in projects which are proposed along the river to develop some kind of resort, parks, multipurpose buildings and contemporary riverfront

Some proposed sites are in present time-

- a) Riverfront development of Gomti (Gomti riverfront channelisation project from Harding bridge to Gomti Wier, Lucknow) (IRWD, 2018)
- b) Other state government's proposals on riverfront e.g., Godavari Riverfront, Kabini Riverfront, Mandakini Riverfront Chitrakoot, Narmada Riverfront Resort, Ganga Rejuvenation in Uttar Pradesh And Bihar Are Proposed with Some Architectural Projects.

**X. CONCLUSION**

In any future projects which are belongs to any riverfront development need all kind of elements and principles for better development of built environment and infrastructure, where this study talks about points which may consider attentionally before any development like flood level and type, water quality and pollution control, environmental analysis where it recommends the green corridor and design of public places. In the last this study provides some guidelines based on inferences which should be follows in future projects for a better development also to avoid the present time riverfront problems. If we consider all the above inferences in any riverfront development project as guideline and strategy it will remove the chance of failures and any kind of problems after design and built up. Also, development becomes more sustainable and better infrastructures in terms of quality, environment and socially connected.

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