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ABSTRACT

Waterways are a vital and productive resource to our environment. As for Canals, Which are made to provide a variety of amenities and services to communities across the world. They are widely used for navigation, irrigation, and drinking water, food, travel, wildlife habitat, connection to places, aesthetic appeal, economic development etc. This thesis project will examine the importance of canal system of Kolkata and identify one typological interventions of Kestopur (Drainage) canal to its urban community and show how canal front design can function as an unifying element for the Salt lake city (Kolkata) and its ecosystem. *"Over half of the worlds future population will be living in urban environments by 2030, which will dramatically increase the stress on a vulnerable network of water syste".* (Bernhardt and Palmer, 2007).

A regeneration of canal can bring awareness to people while improving physical and ecological corridor connections and also provides a unified living society between people and the natural environment.

Abstract

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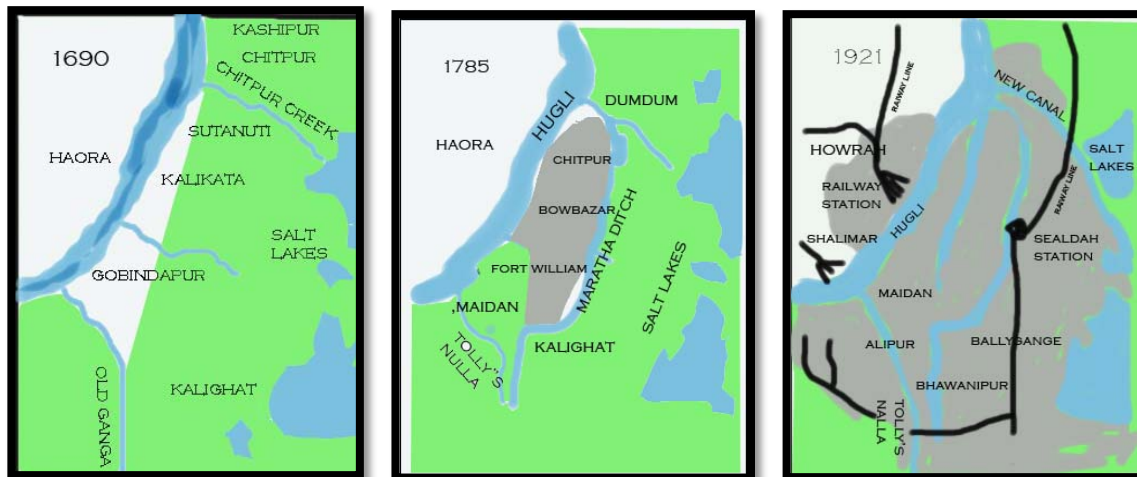
CHAPTER-1

1 Introduction

1.1 Background

When the British settled on the eastern bank of the Hooghly river , on the west, a creek to the north, and by salt lakes about two and a half miles to the east. There were three large villages along the east bank of the river Ganges, named, Sutanuti, Gobindapur and Kalikata. During Maratha rule, West Bengal were threatened by their Invasion. This threat of the Maratha led to the digging of the first canal. Realizing the potential the canal system was conceptualized, implemented and used for the irrigation, navigation system.

In 1947 after partition of Bengal, later extension Saltlake city was declared for the immigrants of Bangladesh as a Satellite township on high population pressure. Initially it was supposed to be the place for the middle income group, but later on the mid of 70s and 80s, Saltlake came to be known for the place of mixed character inhabited by Higher income groups and Middle income groups and the Slums on the Duttabated area.



The Growth and Establishment of Kolkata. (Nair, 1990)

1.2 Need of Study

Keshtopur canal flows from the Hooghly River to the East Kolkata Wetlands to Bay of Bay of Bengal. A part of this canal flows between Salt Lake City and the EM Bypass Road. The Land Use pattern of Salt Lake City varies with different

INTRODUCTION

types of Urban Facade aligned along the length of the canal. The space adjacent to the canal is neglected and is in disuse with wild growth of invasive weeds and garbage, domestic sewage disposal. The canal now acts as the rear end of Salt Lake City. Buildings are oriented towards the internal roads and open spaces, rather than the canal. Incorporating community connection through an ecological solution can provide amenities and aesthetic values that will unify an urban center. Instead of having the environment adapt to us, it is essential that we adapt to it and live within an ecosystem's natural process.



Figure 1: Filled up for highways or destroyed for elevated railways. Figure 2: Blockage of water flow in Kestopur Canal. Figure 3: Water hyacinth and debris along the canal next to NBCC Vibgyor apartments in New Town, Figure 4: Washed-up garbage on the banks of the canal near Aquatica

1.3 Aim and Objective

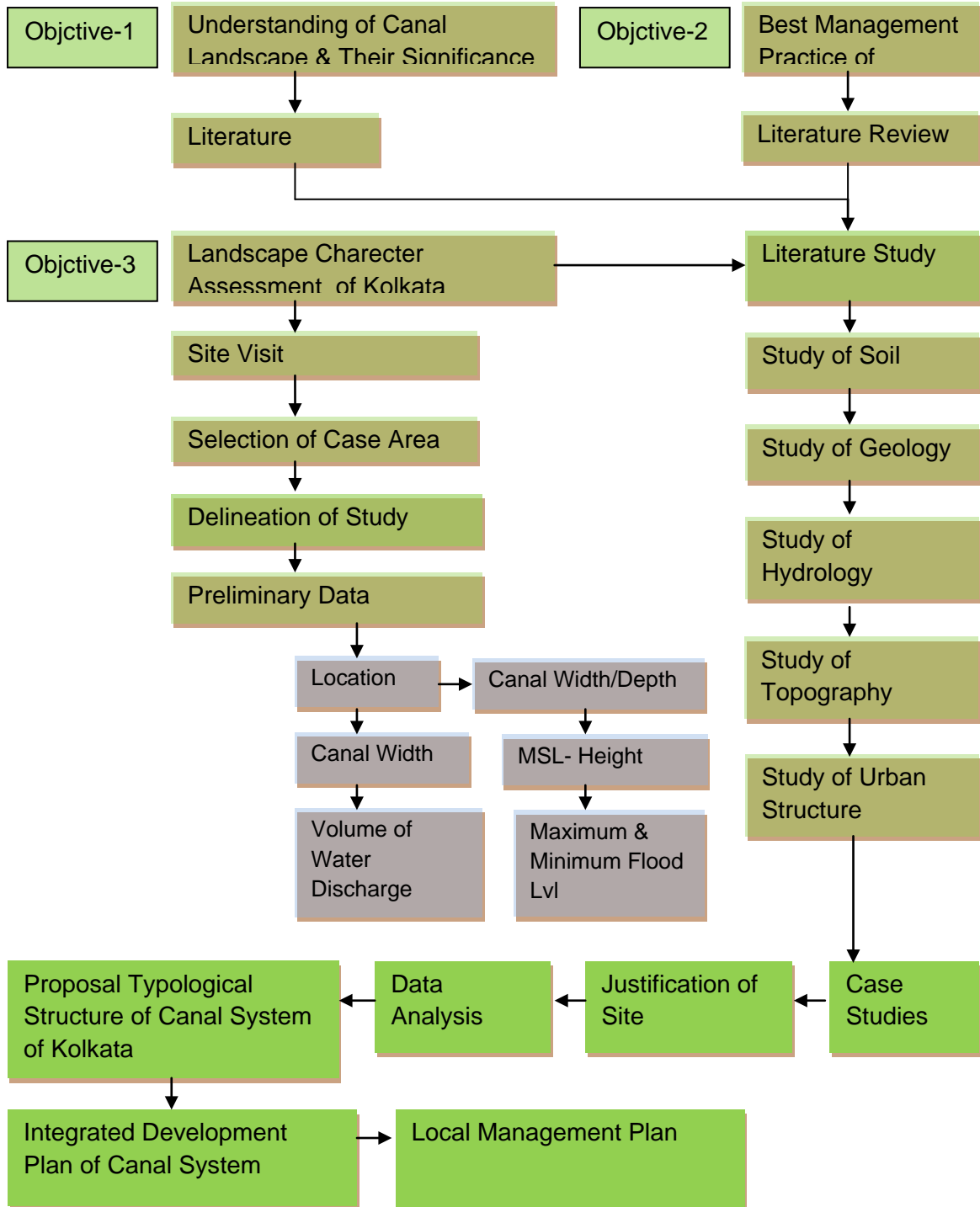
1.3.1 Aim

To re-interpret thriving waterside public open spaces in response to the restoration of natural canal waterfront.

1.3.2 Objective

- I. To understand canal landscapes and their significance.
- II. To identify and study best management practices of the canal of Kolkata region.
- III. To map the canal of Kolkata region & its significance.
- IV. To identify the issues and concerns.
- V. To identify sites for Typological interventions.
- VI. To propose a landscape management plan to regenerate the canal landscape in present context.

1.4 Methodology



1.5 Scope and Limitations

- **Economic benefits:** The Regeneration of canal can increase & encourages the reuse of land and buildings.
- **Social benefits:** It can increase jobs and general economic activity, which may impact on people’s wellbeing in terms of physical and mental health.
- **Environmental and heritage benefits:** Restoration will increase recreational opportunities in the civic center area which can also reduce urban heat Island effect in the city.

1.6 Outcome of the Project

- **Enhances the pedestrian experience:**

Restoring spaces by existing land use spaces for the Institutional area, Hospital Front, HIG Houses, Commercial Spaces, Under Metro Spaces

- Proposed Ghats, Bus Stop, Bridges at every 500m Stretch
- Continuous sidewalks and linear walkway can be multiuse by jogging, Cycling and walking in green corridor

- **Increases wildlife habitat in the urban area:**

The number and range of birds, insects and fish now living in and around the East Kolkata Wetlands can enrich the canal through a specific connecting corridor from wetland-Canal.

1.7 Study Area

The Study area is **Kestopur Canal** of Salt Lake (Kolkata) which lies under North 24 Parganas, gets its water from the West Bank of Hooghly River which connects Kestopur canal (Supply Canal) again gets Diverted as (Kestopur) drainage canal. It starts from Ultadanga -Nayapatti (Sector



Figure 5: Salt Lake City

INTRODUCTION

V).The drainage canal of Kestopur has always been an issues in maintenance & upkeep of the canal is the top priorities for the Bidhan Nagar Municipal Corporation, which led to the cause of significant reason of my thesis study area.

1.7.1 What we have on the Site

- Canal (4 km) as a water body
- Mode of Transportation- Highway, Flyover, Bypass Road, Metro, Primary & Secondary Road
- Indigenous Species , Vegetation, Activities & Function.
- Canal as a buffer space between city & the expressway.

1.7.2 Preliminary Data

- Site Length- 4km
- Canal Width- 10m on the Right Bank & 15m on the left Bank
- Canal Depth- 1.8m & 3m from Road Level
- Discharge: It has a full load discharge of 670 cu ft per second, against maximum requirement at the time of its construction of 272 cu ft per second.



Figure 6:Salt-Lake Ward Boundary

(Bhattacharjee, 2010)

1.7.3 User: Client Description.

1.7.3.1 Client

The client is the Salt lake city as well as Kolkata and other organization working with the waterways, wetland(Habitat, Ecology). KMC (Kolkata Municipal

Corporation), NKDA(New Kolkata Development Authority), Salt lake Irrigation Department, Private Bodies- Planners, Real Estate Developers.

1.7.3.2 Users

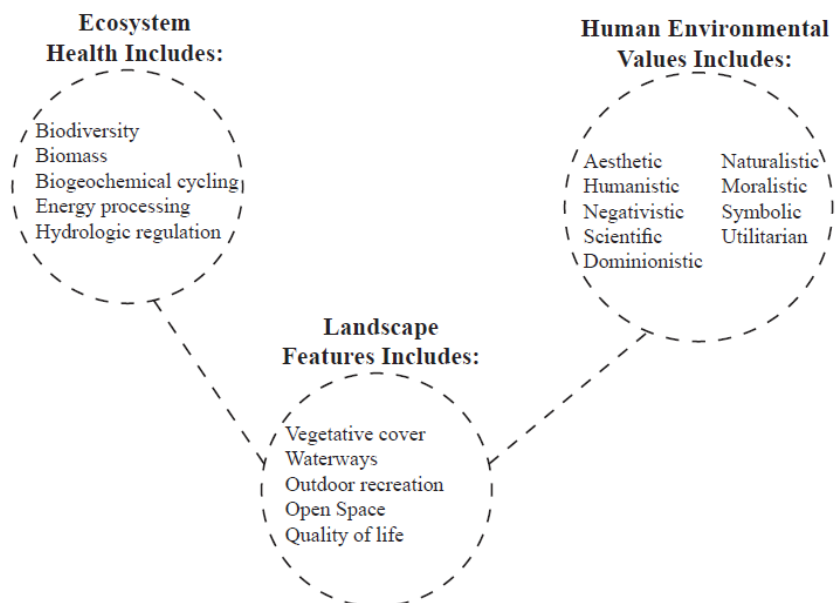
Urban Dwellers: The user group will be local residents, commercial offices, college students who live within the Kestopur canal area. Amenities created for them include biking and walking routes, public transit access, eating availability, open green areas, designated fishing spots, ADA accessibility, and connections to the urban fabric.

1.7.3.4 Tourists

Nature Enthusiasts: An attraction will be designed to incorporate tourist and nature enthusiast to the area. It is anticipated that this entire group will mainly be in spring, summer, and fall for fishing and sightseeing, (Wetland), Niccopark, As a result these users will need trails, green space,, informational Kiosk, parking, eating availability.

1.8 Theoretical Premise Research

It is interesting to see in our highly developed urban age the way interaction with the natural environment can dictate and enhance human and mental well being. This relationship can



be further with 3 elements -Ecosystem health, Landscape features, Human environmental values.

CHAPTER-2

2 Literature Study

2.1 What is Canal Landscape?

Canals are the reasons which provide Irrigation, transportation, from the beginning of the first establishment of canal in Egypt around 4000 B.C. But later in metropolitan cities, most of the canals are left open because of Dug Well, Tube Well were enormously used for irrigation. So this, canals were Rehabilitated as an integrated system in the society and were intended for everyday traffic & accessible to the agrarian classes. So canal edge which may become accessible for the water & land edge corridor in context with the diverse land use, accessing the street, access points throughout the canal, Improve physical & visual access to water is known as canal Landscape.

2.2 Significance of Canal

2.2.1 Canal Components

- I. Main Canal: The canal which gets its supply directly from the river is known as Main Canal (Kestopur Supply Canal).
- II. Branch Canal: Branch canal generally have an advantage low bank failure, high possibility of vegetation growth in banks, leading to increase friction.

2.2.2 Role and Significance of Canal

Ancient Canals: Canals of Babylon were both used for navigation & irrigation purposes connected with the Tigris & Euphrates. More than 80 percent of the canals of Egypt were mostly used for Trade & Commerce.

Figure 7: Egyptian canals linked with Nile River Figure 8: Ancient Canals of Babylon



Chinese Canals: The Yun- Ho or Grand Canal of China were also used for Commerce was an average of (50-100 ft) wider was later restored on the early of 20th Century.



Figure 9: Somewhere in the Grand Canal, China Figure 10: Montargis Canal, France

European Canals: Early French Canals were also used for navigation. Ist modern canal Briare- Montargis & other canals named Orleans, Picardy, Languedoc were later transformed into Ship Canal.

American Canals: Mostly suited for Navigation on its Coastal and river waterways. It was the most important means of transport until the railways were effective.

2.3 Issues & Impacts of Canals

- Over the years, canals are having a problem to supply line with flowing water. Many part of the country have a problem of connecting Dams, Reservoirs, with Feeder lines to the canals. Moreover maintaining navigation becomes a big challenge because of droughts, floods, & breeches in the water supply would frequently cause navigational closings.



Figure 11: Flood in 17th Street of New Orleans Street Figure 12: Illegal houses on Canals on Ho Chi Minh City

LITERATURE STUDY

- These days canals are not remained as the part of organized national network. Canal transport has become expensive in many countries because of varying widths and depths & water supply for irrigation have also stopped due to pressure of Municipal Government Pressure. (Ria Roy, April,2016)
- In India, there are many problems regarding water supply & water qualities in many states. As for Delhi the walls of the **Munak** canal has been damaged. The world's second-most populous city after Tokyo with 25 million inhabitants, relies on a precarious system of supply. It doesn't have adequate surface water and the state's only river, the Yamuna, which provides 12% of water, is polluted. The rest of the supply comes from ground reserves and a canal in Uttar Pradesh state. The state hasn't built, dredged or maintained areas that historically collected water as infrastructure has failed to keep up with rapid urbanization. (Bhattacharya, Feb 22, 2016)



Figure 13: Indian Security Guarding Munak Canal, which supplies water to new Delhi



Figure 14: Damage Portion of Munak Canal

- In a place like Punjab, Groundwater gets contaminated, not only by general pollutants but also with heavy metals & radioactive Uranium, the Punjab government has decided to turn to canals for potable water. The state government has chosen Moga and Barnala districts for a Rs 300-crore pilot project, under which, water



from canals would be purified at treatment plants before being supplied to residents.

- The degradation of the existing canal networks has provoked conflicts between local farmers and new proprietors in Bangkok, especially real estate developers. Such canal deterioration essentially reduces their ability to convey a water supply to feed agricultural lands, consequently leading to the discontinuation of land use for agriculture and its eventual transformation into urban developments. (Davivongs, Yokohari, & Hara, 2012)



Figure 15: Filled Canal, Figure 16: Covered Canal, Figure 17: Narrow and Shallow Canal, Figure 18: Normal Canal

2.4 How Canals of Kolkata work today:

But the very recent eras due to extreme urbanization and up growing density of population with their domestic and industrial wastes also pass through small drains and channels and they finally remove on the canal and the big sized solids like construction debris. Industrial waste and solid wastes causes the congestion in its flow and that also causes the frequent water logging problem with its flooded condition. Theoretical concept to self-cleaning is also being practically incapable. (Roy & Dhali, 2016)

Canals from the Hooghly river gets heavily silted up to the depth of 6-8 ft. In my Study area, it gradually gets contaminated with sewage as it is connected to about 20 percent of the Salt lake household including Central Reserve Police Camp and Bidhan Abhasan, which were supposed to carry Storm water into the canal.

2.4.1 Govt Proposal Plan:

Bidhannagar municipal corporation proposal is:

- To segregate the domestic sewage from storm water by long pipes through Malakpota Khal (Tributary of Belegkata Circular Canal) via Dhapa log gate(Wetland) pumping station.
- Barrier between Kestopur and Nayapatti to ensure that domestic and storm water discharge do not mix. As per estimates given by experts at the meeting held in Bidhannagar municipality on 17 November 2006, this diversion would cost about Rs 25 crores and will take about six months to complete the project.

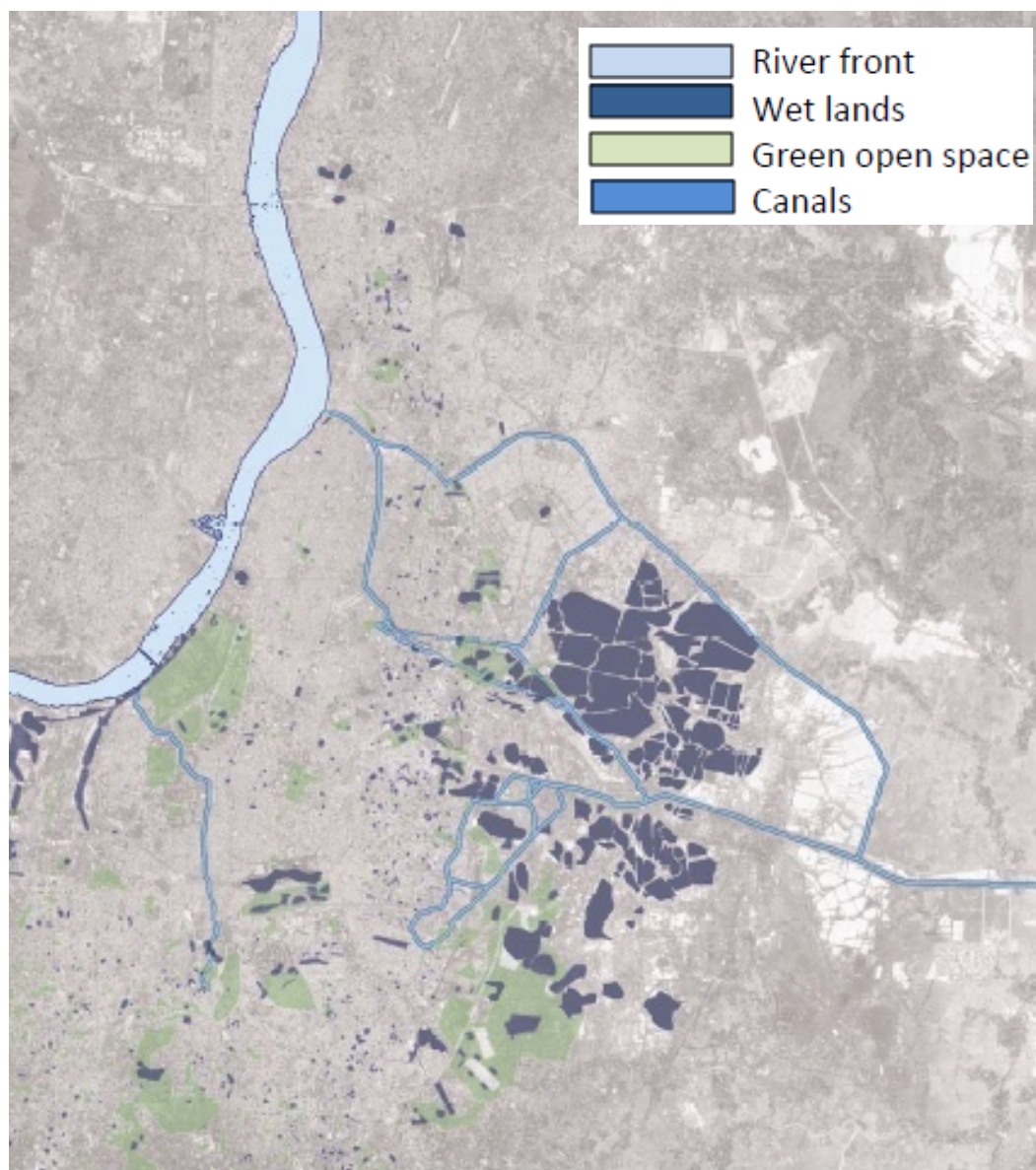


Figure 19: Maps showing Hooghly River, Green Open Space(Maiden), Wetlands, & Canals.

2.5 Legal Frame work of Canal issues in Kolkata Region

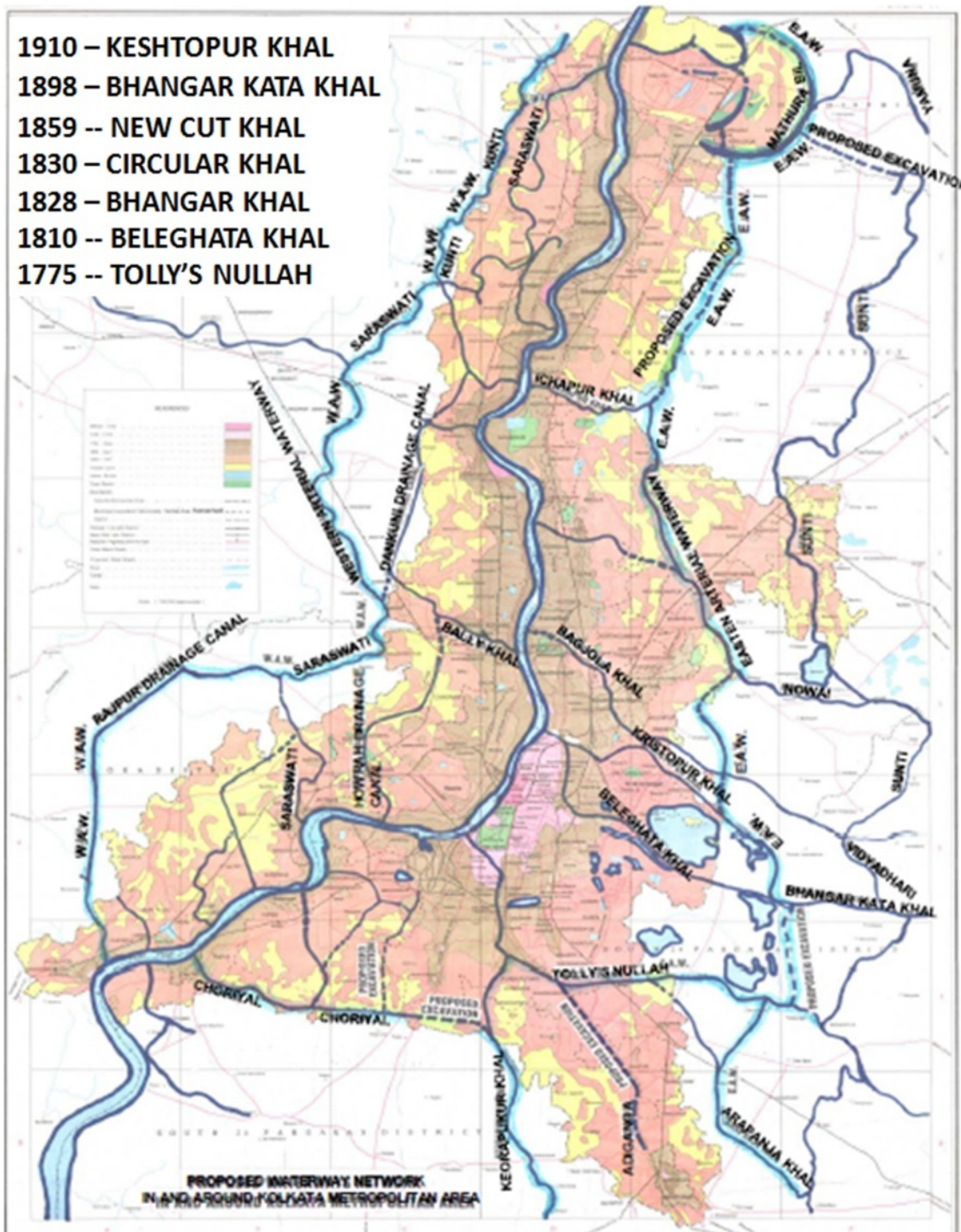


Figure 20: Maps Showing Establishment of Canals Of Kolkata Region

- Land use and built form: Increasing encroachments of the canal banks & their slopes, extension of human settlements in the low lying fringe areas of the city is alarming factor for deterioration of water quality & drainage congestion in the city.

LITERATURE STUDY

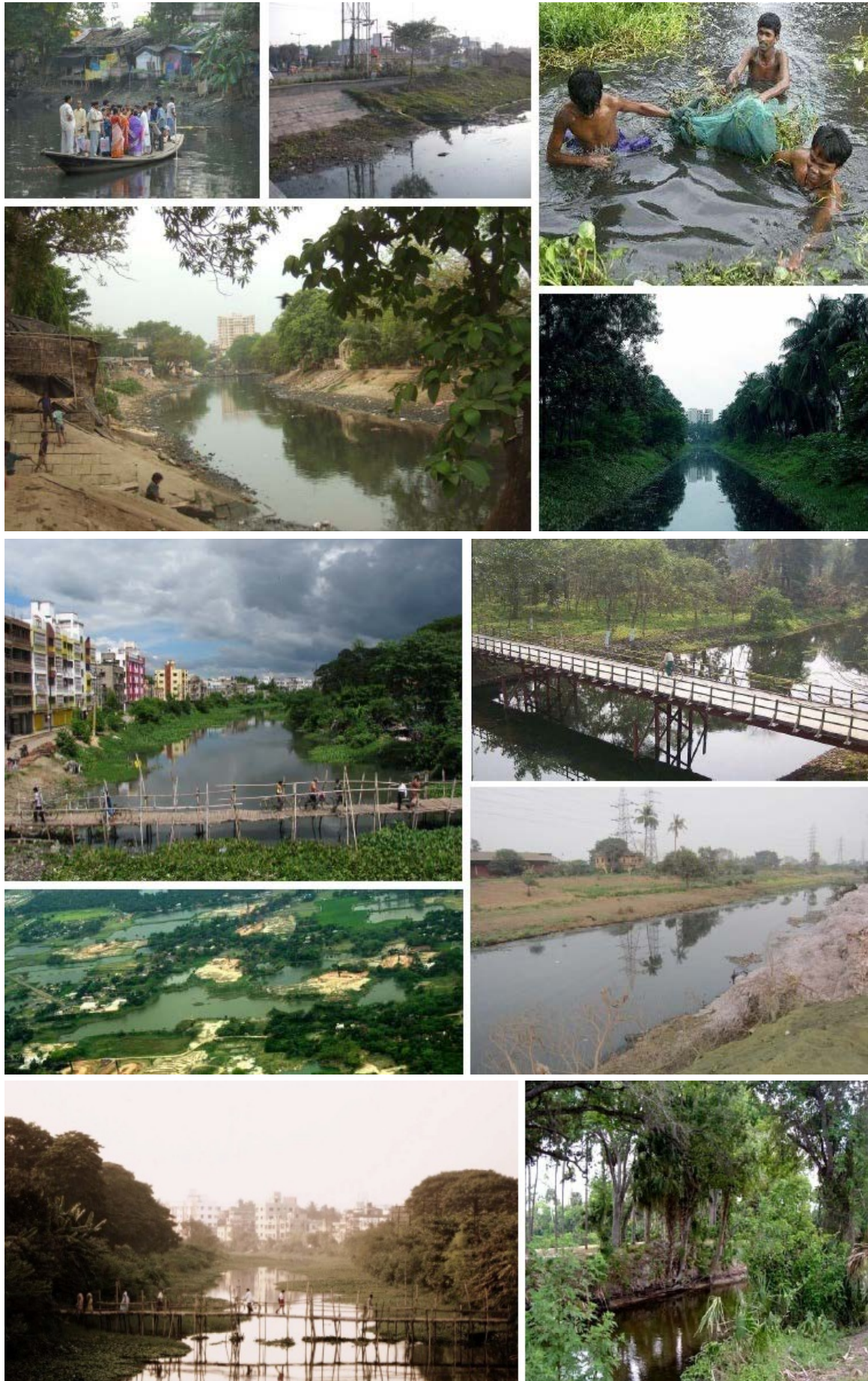
- Ecological Concerns: Municipal drainage channels are passing through East Kolkata & nutrient rich water are entering in fisheries through several feeder channels. Water quality of these canals shows completely anoxic condition & with high BOD and COD indicating high unsustainable aquatic life.



Figure 21: Canals around East Kolkata Wetlands.(Source: Kolkata "The vision for Future")

LITERATURE STUDY

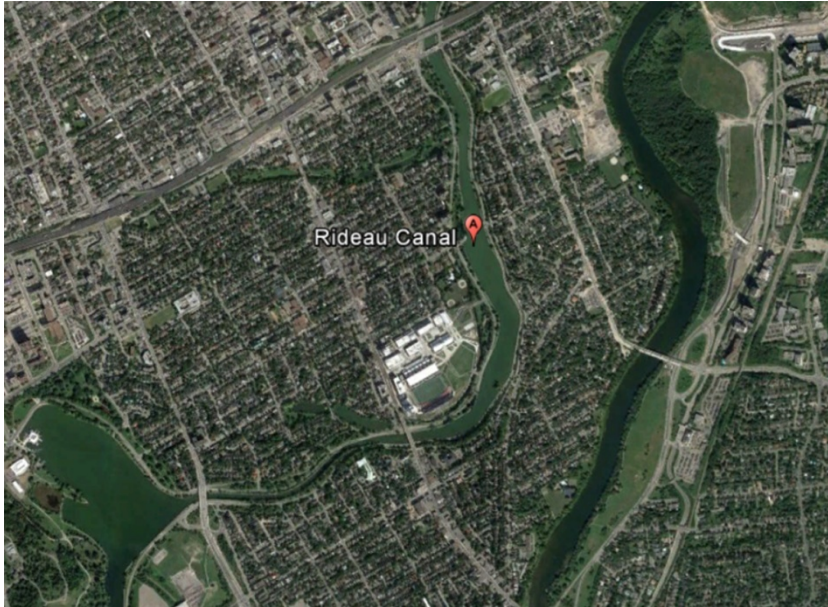
Figure 22: Existing Conditions of Canals of Kolkata



CHAPTER-3

3. Case Studies

3.1 Rideau Canal Ottawa, Ontario, Canada.



3.1.1 Canal Description

Total length-202km.
Renovated 14km
Depth 1.5m (min)/
20m (max)

3.1.2 Proposed Components

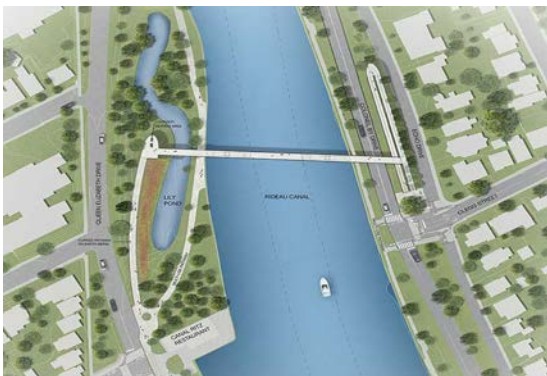
a) Introduction of Fishing, Wildlife,

Parks, Hiking, Canoeing, Group Tours.

b) Beautify and restore the Lily Pond.

c) Protecting the oak tree to improve public space with plaza.

d) Widening of bridge and increase pedestrian and cyclist on the bridge.



3.2 Grand Western Canal, United Kingdom.



3.2.1 Canal Description

Total length-22km.
Renovated 18km
Depth 5m

3.2.2 Proposed Components

- a) Boating on horse drawn barges is an unique and remarkable experience in UK.
- b) Cycling has become a popular way to explore the Country Park.
- c) Great wildlife experience of 11 miles canal. Birds-Moorhens, Mute Swans, Mallards, Kingfisher.



CASE STUDY



3.3 Ashton Canal, North West England



3.3.1 Canal Description

Total Length-10.8 KM,
Depth-4.2 m

3.3.2 Proposed Components

- a) Restored access way for the walkers, cyclists & wheelchair users
- b) Portland basin museum across the canal to the right.

CASE STUDY

c) The locks are renewed for Debris which is currently in restore stage.



3.4 Monmouthshire & Brecon Canal, England



CASE STUDY

3.4.1 Canal Description

Total Length-56 KM,

Renovated-6.8 Km

Depth-6.7 m

3.4.2 Proposed Components

- a) Up gradation of access way and parking to canal side
- b) Provide Public walks and other recreational use
- c) The old wharf buildings have been reused by the Brecon Theater and access is provided by a new canal Bridge.



3.5 Montgomery Canal, England



3.5.1 Canal Description

Total Length-53 KM,
Renovated-36 Km
Depth-3.3 m

3.5.2 Proposed Components

- a) Conservation of existing landscape i.e. Flood plain , Shallow Rolling Valley, Isolated Border hills.
- b) Provisions of Public Space Connections and Recreational Opportunities.
- c) Restore riparian & in stream habitats i.e. Biological needs of wildlife- fish, amphibians, reptiles, birds, mammals.



3.6 Bradford Canal, West Yorkshire, UK.



3.6.1 Canal Description

Total Length-
29 KM,
Renovated-
5.6 Km
Depth-2 m

3.6.2 Proposed Components

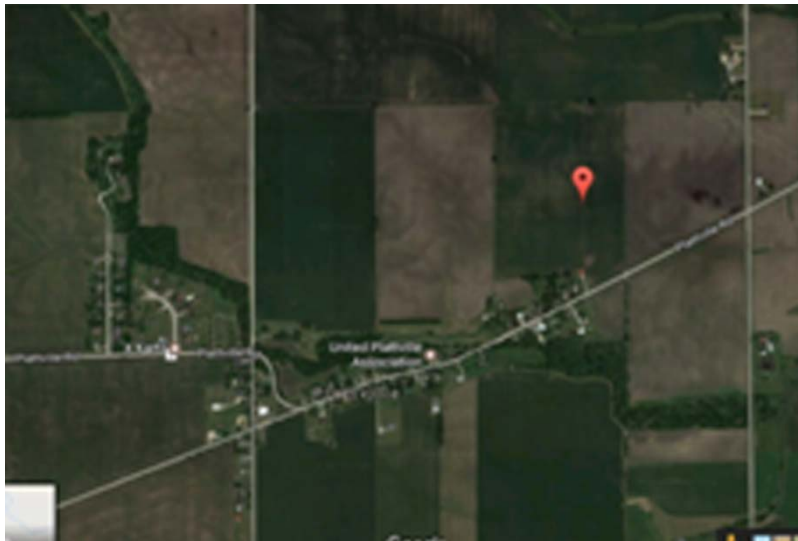
1. Introduction of green Infrastructure to increase the land value.
2. Creating a more attractive and engaging market place and a public square, as a focus for the town centre.
3. Tourist Information Centre. Improved Plazas, shops, cafes.



3.7 Illinois & Michigan Canal, Chicago, USA

3.7.1 Canal Description

Total Length-92 KM,
From Mississippi River
Wide- 18m
Depth-1.8 m

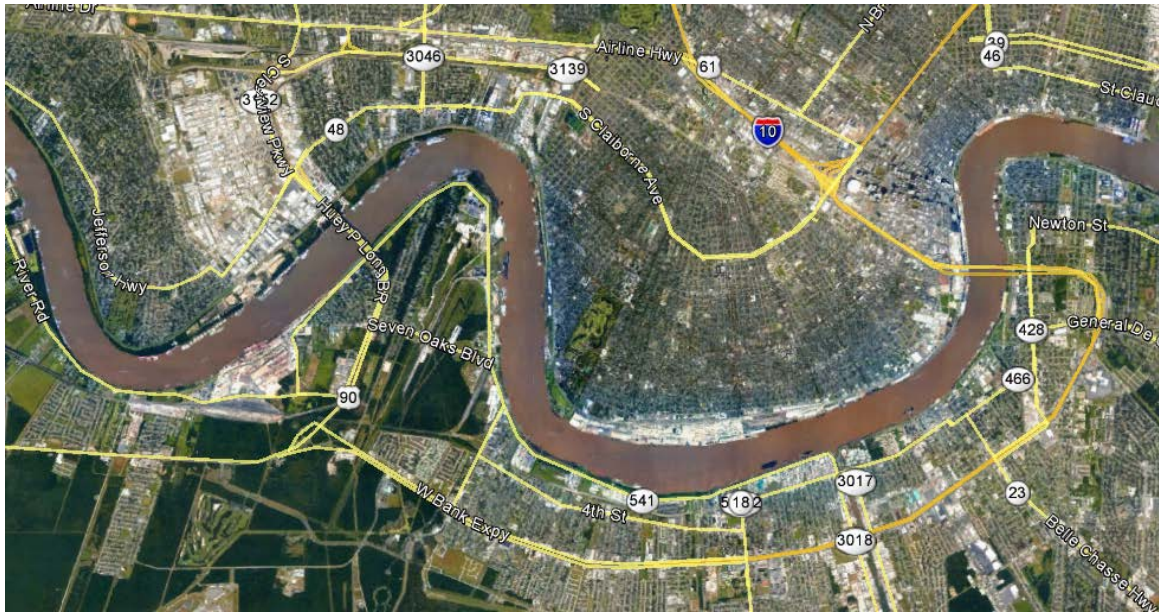


3.7.2 Proposed Components

- Restoration of Lake and walking paths along the Goose lake prairie.
- Preservation of 150 acre Lakes with several small island used for nesting of different bird species.
- Restoration of Public Park including wetlands, 10 acre of manmade lake.



3.8 Jefferson Parish Canal



3.8.1 Canal Description

Jefferson Parish Canal was a Drainage channels initially. The renovated area are divided in different segments, or zones marked geographically according to intersecting cross sections. The design enriches the lifestyle of Parish Residents.

The social, motivated and caring community members of Jefferson Parish are uniquely qualified to nurture a valuable new amenity. Our recommended solutions embody the sincere belief that the people of Jefferson Parish can bridge the gap between design and reality to enrich opportunities of the place we call home.

4 How it Works

PHASING OF IMPROVEMENTS

One entity cannot go at this challenge alone. Collaboration is the key. Use our redrafted master plan as a guide, coordinate the improvements and accomplish small projects to show progress. People want to support success. To ensure the project is implemented in a quality manner the quality more resources will appear - leading benefits to complete the overall vision. The space belongs to the community, they are the backbone to its success.

Our design solution was developed with this component in mind. Everyone can play a meaningful role. The regional plan of improvements and program can be identified in phases. Each phase brings the community a more functional and beautiful space to enjoy. The program and maintenance by utilizing volunteers and communication with the community is an imperative to the success of this project on the design solution provided. Each call of the solution connects a sturdy bridge that connects ideas to successful reality, shows a beautiful and functional open drainage canal.

5 Simple Rules

- 1. Use Your Assets** - Every site has unutilized assets - use them to your advantage. The Canal - Under Used Green Space - Excess Construction Rubble - Community Members
- 2. Get Your Hands in Order** - Accomplishments begin to appear. Improve Each To Program Canal One by One - First And Last Use First - Rubble Removal
- 3. Get in the Win Column** - Small Projects Today - Big Projects Tomorrow. Small K Canyons, Trench Day Cans - Anchor Street Landscapes. Long Business Park - Gabion Installation - Riverside
- 4. Focus the Work** - Fragmented work makes little progress. Beautifully in Block - Focus work Block by Block starting at each end and work to the center.
- 5. Document It** - Capture photos and measure made improvements strategies transformable. Block Party Volunteer Checklist - Personal Return Resources List - "Cash Star" International Web Video

5 Implementation Strategies

BUILDING BRIDGES
Bridging the gap between ideas on paper and reality on the ground.
Information - Contacts
People - Supplies
Organization - Support
Efficient - Communication Guidelines

LEADERSHIP
Building upon great existing partnerships, continued leadership and coordination is imperative.
Jefferson Parish Government
Department of Drainage
Department of Planning
Jefferson Parish Sheriff's Office
Jefferson Parish Public School System
JEDCO/Jefferson EDGE

PARTNERS
Teams with great organizations already in place.
Businesses
Local Residents
Friends of Jefferson the Beautiful
Business Civic Association
Business Owner's Clubs
Surrounding Churches/Temples

Why Volunteer?

- Excellent source of exercise
- Improves mental health
- Community Ownership
- Social Benefits
- Support Local
- Greater % of success when Volunteers take part

Spread the Word

SETTING THE COMMUNITY STANDARD
The impact of this solution will be exponentially greater if it is well documented and openly shared with neighboring communities. By publicly highlighting our canal revitalization movement both online and in-person we can raise awareness for this important cause and illustrate the difference an empowered community can make.

Recommended Marketing Materials:

- Community manual detailing various tasks and programs
- Comprehensive website with interactive calendar of events
- Living and informative social media page (Facebook, Twitter)
- Custom-branded t-shirts, bumper stickers, hats, etc.

WHAT GOES AROUND...
Partners: The most substantial advantage of this solution is not only its ability to effectively transition into similar communities, but also its power to remain as a living force within Jefferson Parish. Once the communication channels for Viva L'Expérience are established they will become assets of their own. Here in our community itself will allow a collection of talented, motivated citizens whose ability to transform a vast public space into a valuable amenity and active element to build a life in Jefferson Parish as well. Ultimately Jefferson Parish's motto is a perfect reflection of the aspirational spirit which this solution is built upon: *Partnership, indeed, lives here.*

GET WITH THE PROGRAM

- CATCH DAT:** Run Canal and on open program to coordinate individual participants in the Parish-wide program to reduce streamer runoff!
- LIVING SCULPTURE:** Encourage that those individual participants to include participants to the whole connecting the concrete to and enjoy.
- TREE-PLANTING DAY:** Encourage on a monthly basis by planting a tree together and serving the growth as part of the new canal strip.

"MAKE IT COUNT" INCENTIVES

- 1 for FUN:** EXERCISE, STRESS RELIEF, SCHOOL SERVICE HOURS
- 2 for YOU:** TAX INCENTIVE HOURS, RAIN BARREL CREDITS
- 3 for FREE:** "1 FOR FUN" + "2 FOR YOU" = DISCOUNTS FROM LOCAL BUSINESS SPONSORS, PUBLIC RECOGNITION

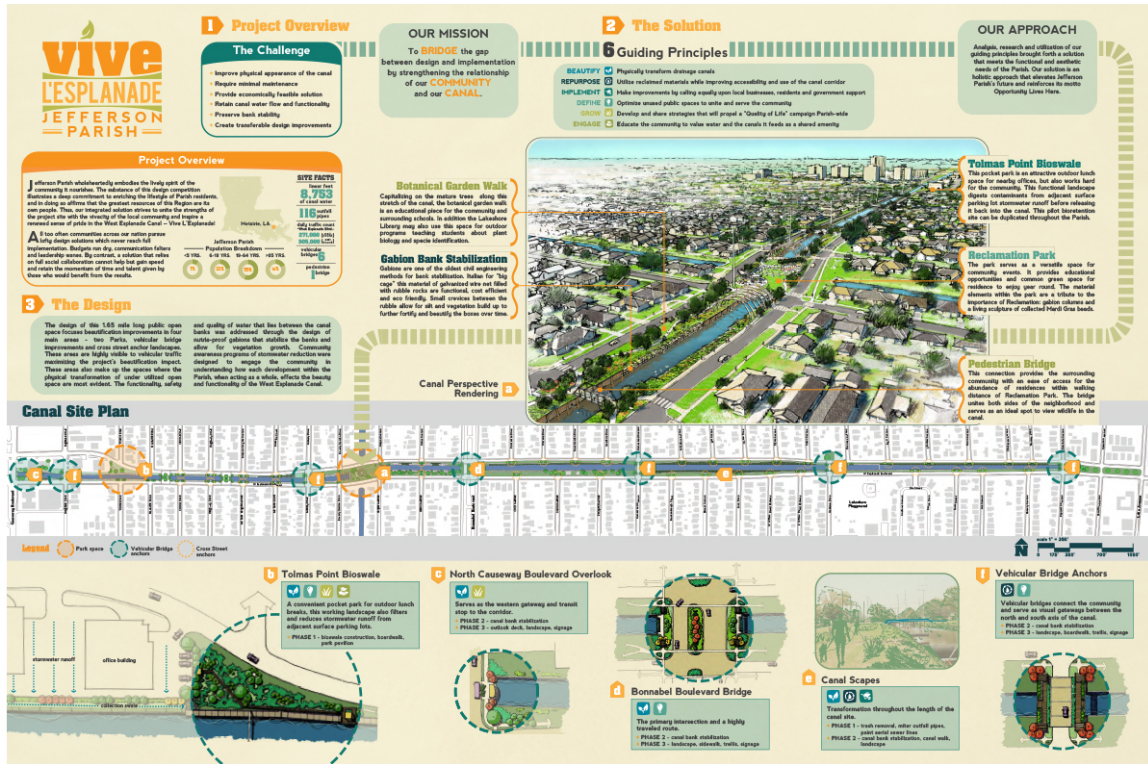


Figure 23: Competition Sheets of Jefferson Parish CanalSource:(Cadence Studio Work, FORT LAUDERDALE, FLORIDA

3.8.2 Design Treatments

3.8.2.1 Shade Trees



Opportunities exist for the planting of shade trees along segments having ample TOB widths. Establishing a mature tree canopy when possible will provide environmental and aesthetic benefits.

3.8.2.2 Ground Cover

Where Top of Bank is 5' or less in width, ground covers may be planted instead of turf grass. Once established, ground cover vegetation may require less maintenance than turf grass, and may spread down the bank slope to aid in bank stabilization.

3.8.2.3 Open Meadows



Meadows possess a more wild, natural character than turf areas. They are typified by native grasses, forbs, wildflowers, and other herbaceous plants. These areas are managed, but not necessarily mown or manicured with any frequency.

3.8.2.4 Accessible Pathways



Being near water is a universal human desire. Affording people of varying ages and abilities the opportunity to walk along the water's edge in safety is something that should be considered where conditions for pathway development are favorable.

3.8.2.5 Context Sensitive Parking

Commercial parking areas on the Top of Bank near Causeway abut the descending bank. Open concrete drains designed to convey storm water down the bank and into the canal are in disrepair.

3.8.2.6 Special Design Areas



Vehicular crossings, termini design at the beginning and ends of canal segments or at key nodes, and green space design are areas of special emphasis.

3.8.2.7 Vegetated Slopes

Slopes that are either seeded with grass or are planted with other herbaceous materials and shrub massing are cost-effective, attractive, and protective against erosion. Plantation requires geotextile support to secure bare soils.

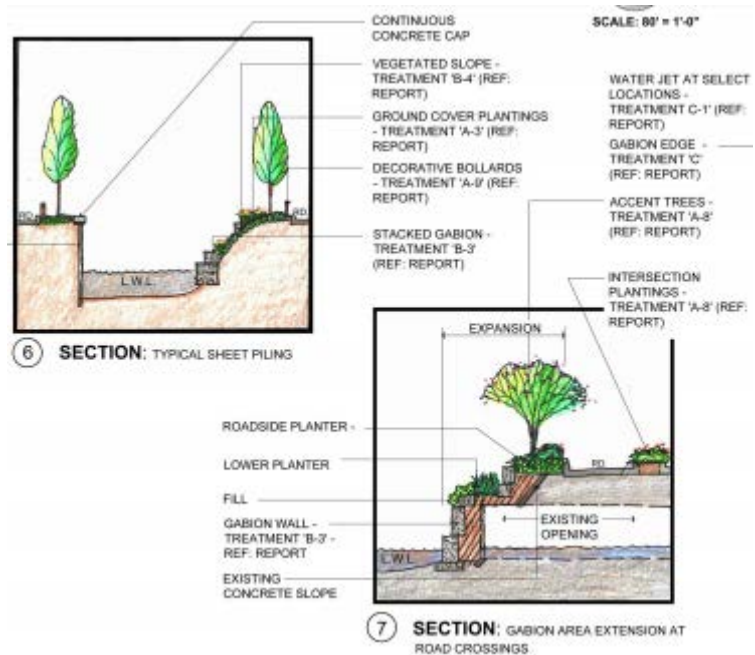
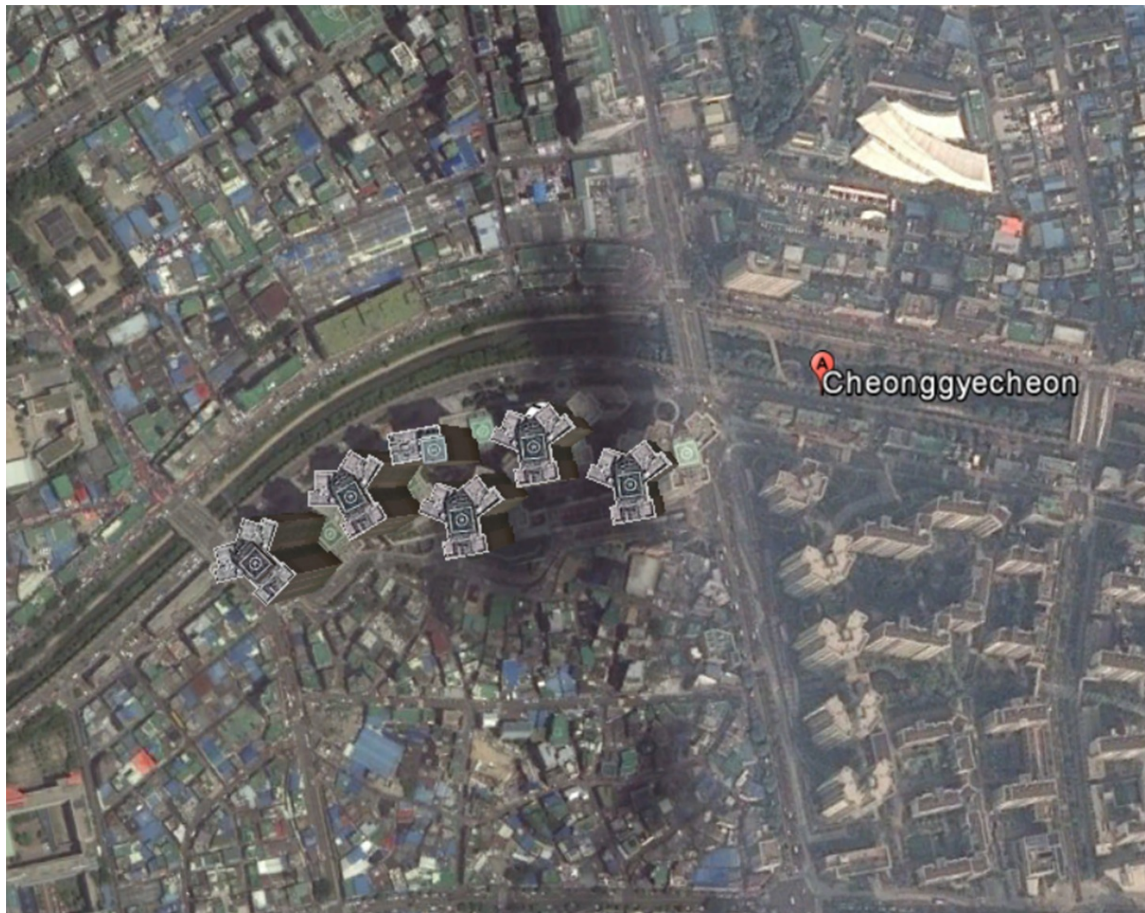


Figure 24 Typical Gabion Canal Water Edge Treatment with water Jet. (David)

3.9 Cheonggye Cheon, Seoul , South Korea



3.9.1 Canal Description

Total Length-38.7 KM,
Renovated-5.84Km
Width-28-85M
Depth-1-1.2 m

3.9.2 Canal Background

Initially it was covered by 6km long (50-80)m long road structure, with 5.86km long and 16m wide of Cheonggye elevated highway over the road, and 11km of the intercept sewage system under the road. More than 168 thousand cars a day were running Cheonggye Street and Cheonggye elevated highway, In the 1980s, the impacts of the highway and effect to the economic



decline of the central areas became clearly recognized. People began to be concerned about air pollution from the highway, health risks from unsanitary conditions and a decreasing stability of the aging infrastructure. A group of academics and environmentalists developed a community based master plan for demolishing the

10 lane highway and restoring the stream. (Cheong Gye Cheon Stream Restoration, 2015)

3.9.3 Canal Proposal

Flood level estimated by 200 years frequency of Rainfall and developed a high cavity wall



Figure 25: Section of estimated flood level 200 yrs

3.9.4 Proposed *Components*

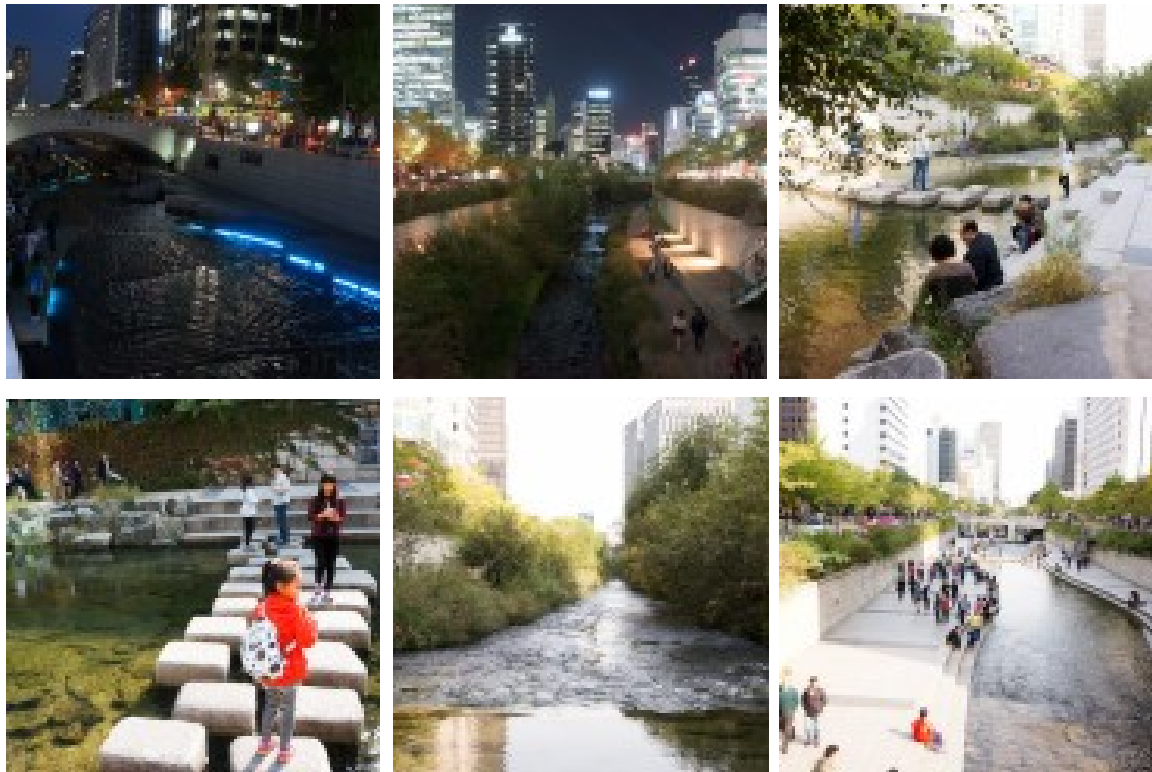
- a. Widening of streams for one-way two-lane roads, sidewalks and loading/unloading space for smooth traffic flow after the restoration.
- b. The northern side of the river provides seating and strolling areas for the people while the southern side designed for plants and wildlife.
- c. Small squares, public art of works, waterfront decks are located at regular intervals along the river.

3.9.5 Benefits

- a. Urban renewal Revitalization
- b. Economic growth and Tourist attraction
- c. Public access to the River
- d. Historical and cultural values reflected in the design
- e. Significant ecological Improvement

- f. Air and water quality improved
- g. Reduction in air temperature (cooling effect) in surrounding area by an average of 3.6°C demonstrated by thermal imagery

Regeneration Cheonggyecheon Canal, in 6 contextual Background



Source: (Cheonggyecheon Restoration Project)

3.10 The Fen River in Taiyuan, China

3.10.1 Canal Description

Fen River is the mother river of Taiyuan City. It runs from north to south through the city and fosters the history, culture and development of the region. The project site is located at the joining point of old town and new urban area with a total of 2.57km² (50 Hectares) riverfront landscape area.

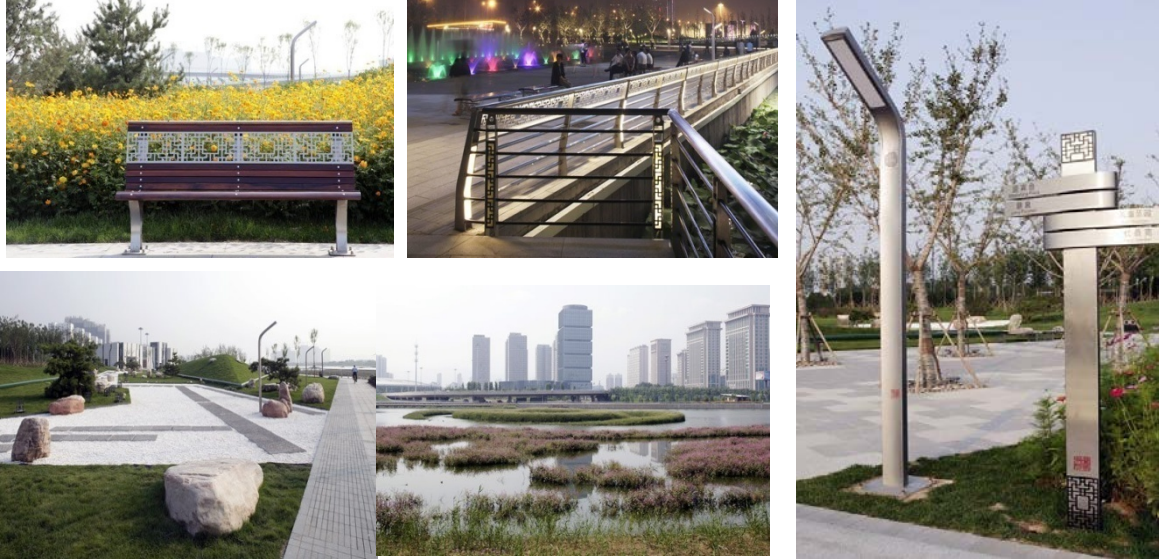
3.10.2 Proposed Components

Focuses on Communal spaces for local residents, including community garden, playground, water feature.

The east park aims to create new life experience and new celebration spaces, and to enhance social interaction and community.

3.10.3 Design Elements

The concept was to be inspired from old Fairy tales design and include traditional design elements applied in landscape design details, (railings, lighting poles, bridges, benches, etc.)



Source: AECOM River for design for Taiyuan Fen River Waterfront

3.10.3.1 Native Plant Material

Plants were chosen by their seasonal variation as well as their toughness and tolerance to the dry and cold climate in Northwestern China. Woody plants in the park provide shelter from cold wind and also provide a transition between structures and open fields. Diverse native plants occupy much of the site

3.10.3.2 Designed Wetlands

To improve water quality they have create some small habitats for birds and other animals, but also perform as “living” education facilities for people to carefully preserve the ecology of Fen River. Those plants floating in the river also provide a beautiful landscape for Taiyuan people.

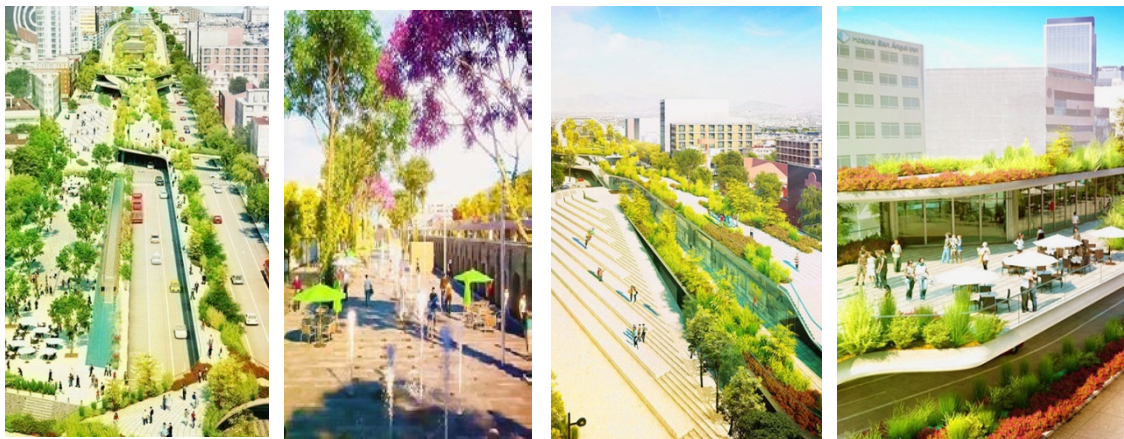
3.10.3.3 Master Plan Taiyuan Fen River Waterfront



3.11 The Restoration of Mexico City Corridor

3.11.1 Canal Objective

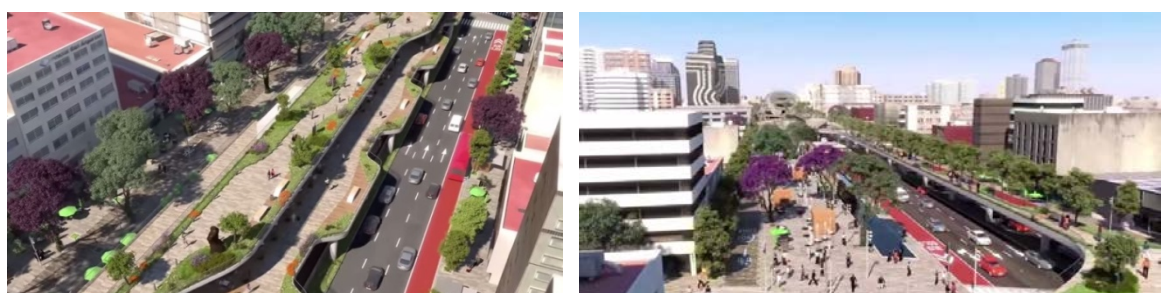
- a. Restoration of 1.3 km long cultural corridor will be completed in one of the city's oldest and busiest streets and expected to be completed by 2017. (Green, 8.27.2015)
- b. 10 Lane Highways from West- East between Chapultepec Park & the Centre of the City. Heading east to the west, the elevation will gradually increase, as new pedestrian- inviting people up onto the elevated promenade.



3.11.2 Canal Proposal

Providing Pedestrian cyclist and more space for socio- cultural interaction, without attracting the traffic & vice versa. The whole idea is to build a raised landscape that includes green areas, shops, cultural spaces, wider sidewalks and bicycle lanes. At the bottom level there should be an ideal amount of space for public transport and private vehicles.

The cultural aspect of the project is probably the most attractive and different feature of this corridor, it is designed to have specific areas for art, history and cultural expressions. For example, it will feature a theater-like space for outdoor screenings where people can gather to watch movies and films.



CHAPTER-4

4. Regional Site Study

4.1 Climate



Kolkata has a Tropical wet and dry climate. The annual mean temperature is 24.8 °C (80 °F). monthly mean temperatures range from 15 °C to 30 °C (59 °F to 86 °F). Summers are hot and humid with temperatures in the low 30's and during dry spells the maximum temperatures often exceed 40 °C (104 °F) during May and June. Winter tends to last for

only about two and a half months, with temperature 9 °C – 11 °C (48.2 °F – 51.8 °F) between December and January.

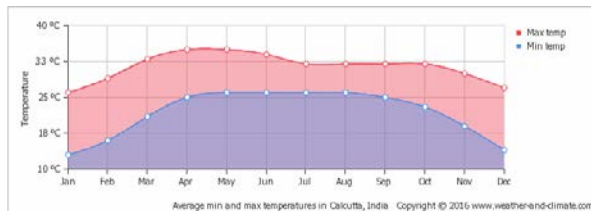


Figure 26: Average Min & Max Temperature over the Year

Figure 27: Average Monthly Rainy days over the Year

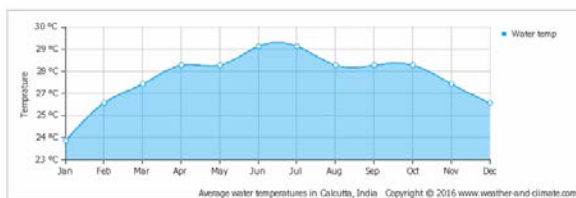
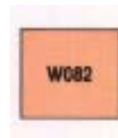


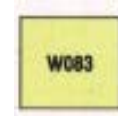
Figure 28: Average Water Temperature over the Year

Figure 29: Average Humidity Over Year

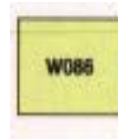
4.2 Soil



Very deep poorly drained, fine loamy soils, occurring on level to nearly level upper delta plain with loamy surface & subject to severe flooding



Very deep poorly fine soils occurring on level to nearly level upper delta plain with clayey surface & subject to severe flooding.



Very deep poorly fine soils occurring on level to nearly level upper delta with interdistributary sediments with clayey & moderate flooding associated with deep well drained, sandy soils.

Source: (Das & Chattopadhyay, 2009)

4.3 Geology

Kolkata is situated over a huge pericratonic tertiary basin with enormous thickness of fluvial-marine sediments. The basin can be divided into three structural units: The westernmost shelf or platform, the Central hinge or shelf/slope break and deep basined part in the east and south east that open in the present bay of Bengal. The Kolkata city located over the western part of the hinge zone across which sediment thickness and facies significantly varies for shelf area in the west to deep basin area in the east. The hinge zone and the shelf area are traversed by many faults; some of them are reported to be tectonically active at present (Nandi 1994). The hinge zone is about 25 Km wide that occurs at a depth of about 45000 m below Kolkata. The total sedimentary thickness below Kolkata is of the order of 7500 m above the crystalline basement; of these the top 350–450 m is Quaternary, followed by 4500– 5500 m of tertiary sediments, 500–700 m trap wash of cretaceous trap and 600–800 m perm carboniferous Gondwana rocks. (Das Diptendra, 2009)

4.4 Hydrology

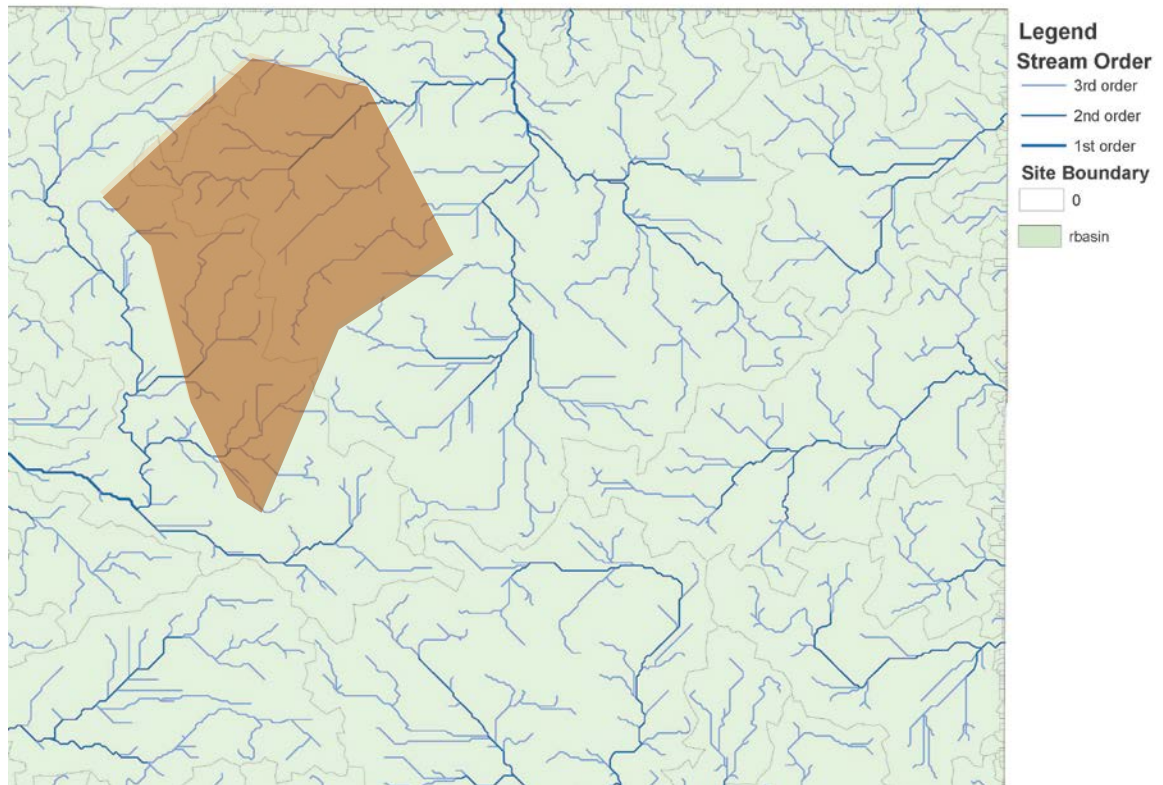


Figure 30: Figure represents the hydrological map of the study region

4.5 Layout Plan

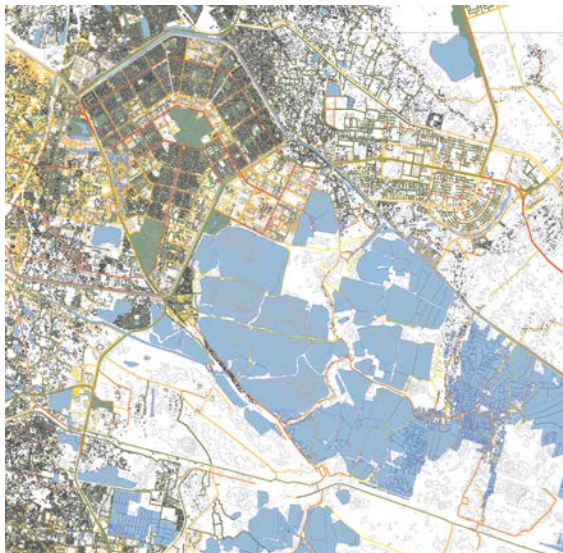


Figure 31: Map Showing Wetland, Contour

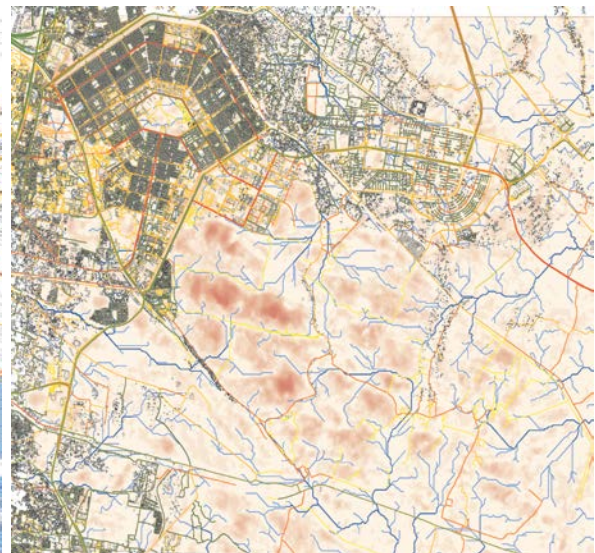


Figure 32: Map Showing Elevation Model

CHAPTER-5

5. Delineation of the Study Area



Figure 33: Geographical location of the site and the Surrounding area



Map of Salt Lake City

5.1 Justification of the Site

After analyzing the canal system of Kolkata & the setting of Salt Lake City, I have considered my area of canal beside the Salt lake and the VIP Road (Salt lake Bypass Road). The Regeneration of Kestopur Canal 4km Stretch can synthesize the concept of canal system of the Kolkata Region.



5.1.1 Wetlands

On the East of Kestopur Canal is the Ramsar Convention Site, which is about 12,500 hectares helps in water treatment, Habitat of Invertebrates, Mammals, Fishes, Birds, Maintain Hydrological Functions-(Flood Control, Ground water Recharge), Socio economic (consumptive & Non Consumptive use value)

5.1.2 Wetland Corridor and Biodiversity



Figure 34: Backswimmer



Figure 35: Water Scorpion



Figure 36: Nymphs of Damselfly



Figure 37: Indian Pond Heron



Figure 38: Little Egret



Figure 39: Indian Cormorant

5.1.3 Challenge of Highway, Flyover & Metro



There is a great challenge to design a linear park through this centre of Salt lake City & Suburbs in surprising ways. The metro and flyover gives visitors views of the city they want to find anywhere else. The Regeneration of the stretch may create good vistas as in

Urban Theatre transform the empty canal back into a space for Jogging, Walking, and Public art exhibits throughout, exercise parks, playground and other greenways.

5.1.4 Diverse Land use



Figure 40: Commercial Hub Buildings



Figure 41: Residential Buildings



Figure 42: Institutional

5.1 Transportation Layout plan and Existing Skyline

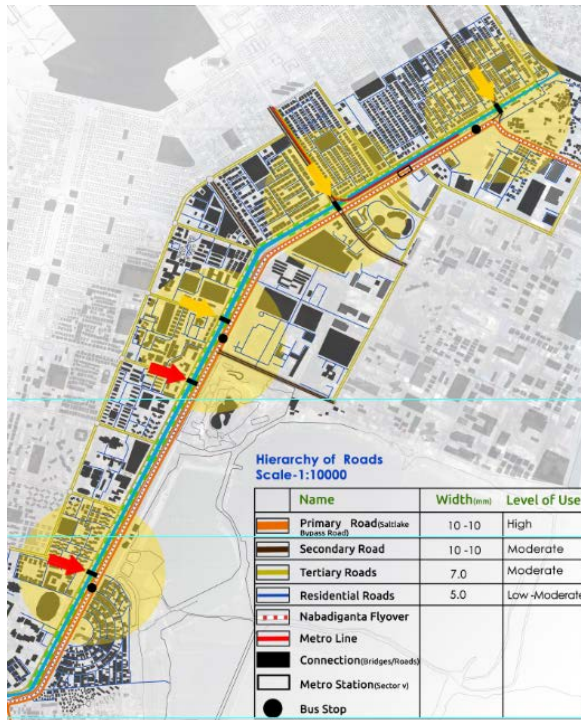


Figure 43: Hierarchy of Roads

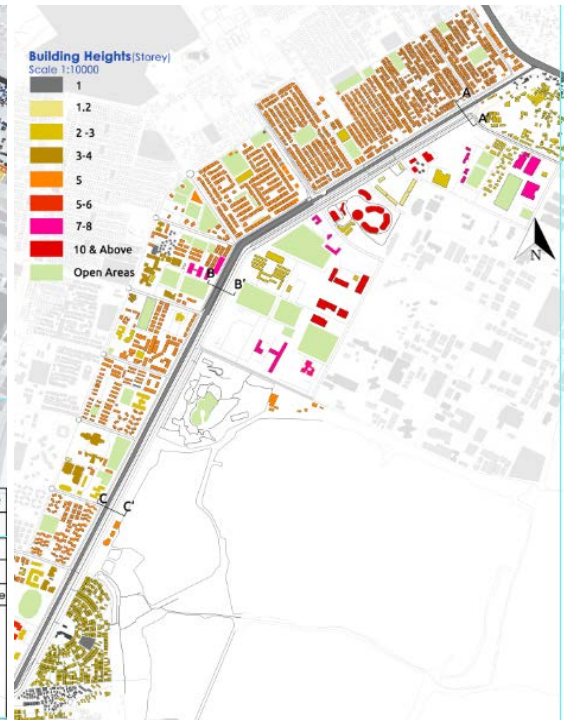


Figure 44: Existing Skyline

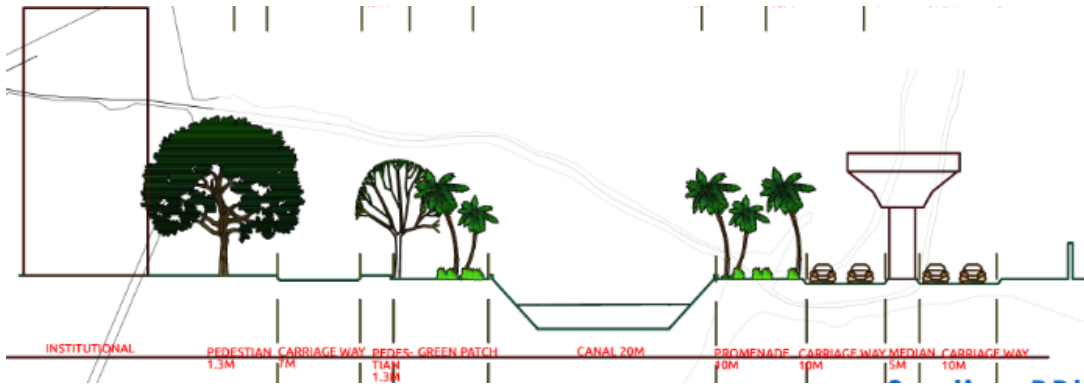
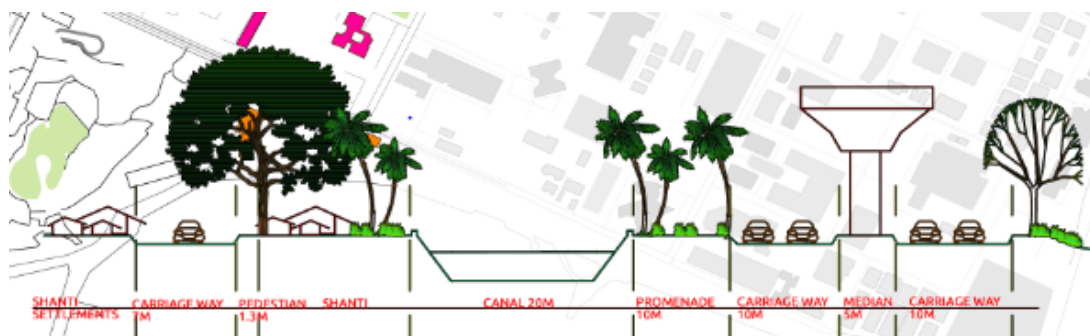


Figure 45: Section From Institution

5.2 Existing Canal Sections



5.3 Water Quality Data

A 2009 Study on ground water quality on Kestopur Khal looked at 25 samples and found High levels of metals. (Source Status on ground water quality in India II, Anon 2009, Central Pollution Control Board, New Delhi.)

Parameters	Pre- Monsoon (in mg/l)	Post- Monsoon (in mg/l)	Desirable Limit (in mg/l)
	203-995	179-1002	300
Total Dissolved Solids	614-1978	499-1939	500
Chloride	45-805	62-825	250
Iron	0.275-21.38	0.437-5.30	0.3
Alkalinity	200-552	179-1002	200
Magnesium	0.011-0.889	0.016-0.985	0.1
Cadmium	0.008-0.028	0.001-10.003	0.01
Zinc	0.213-12.2	0.210-9.17	5
Arsenic	0.37	0-0.065	0.05
Mercury	0.001-0.005	0-0.0003	0.01

5.4 Hierarchy of Roads

5.4.1 Access way:

Busy access way of Salt lake Bypass Road(Primary Rd) have huge noise and traffic rush, causes huge pollution during Office hours. Canal side road have very minimal activity with dull environment after evening.

	Name	Width(mm)	Level of Use
	Primary Road (Saltlake Bypass Road)	10 -10	High
	Secondary Road	10 -10	Moderate
	Tertiary Roads	7.0	Moderate
	Residential Roads	5.0	Low -Moderate
	Nabadiganta Flyover		
	Metro Line		
	Connection (Bridges/Roads)		
	Metro Station (Sector v)		
	Bus Stop		

5.4.2 Pedestrian Walkway

1. Accommodate better Pedestrian network to integrate better mode of public transport.
2. Encourage walking/ cycling through safety design.
3. Ensure the design and quality of the street and

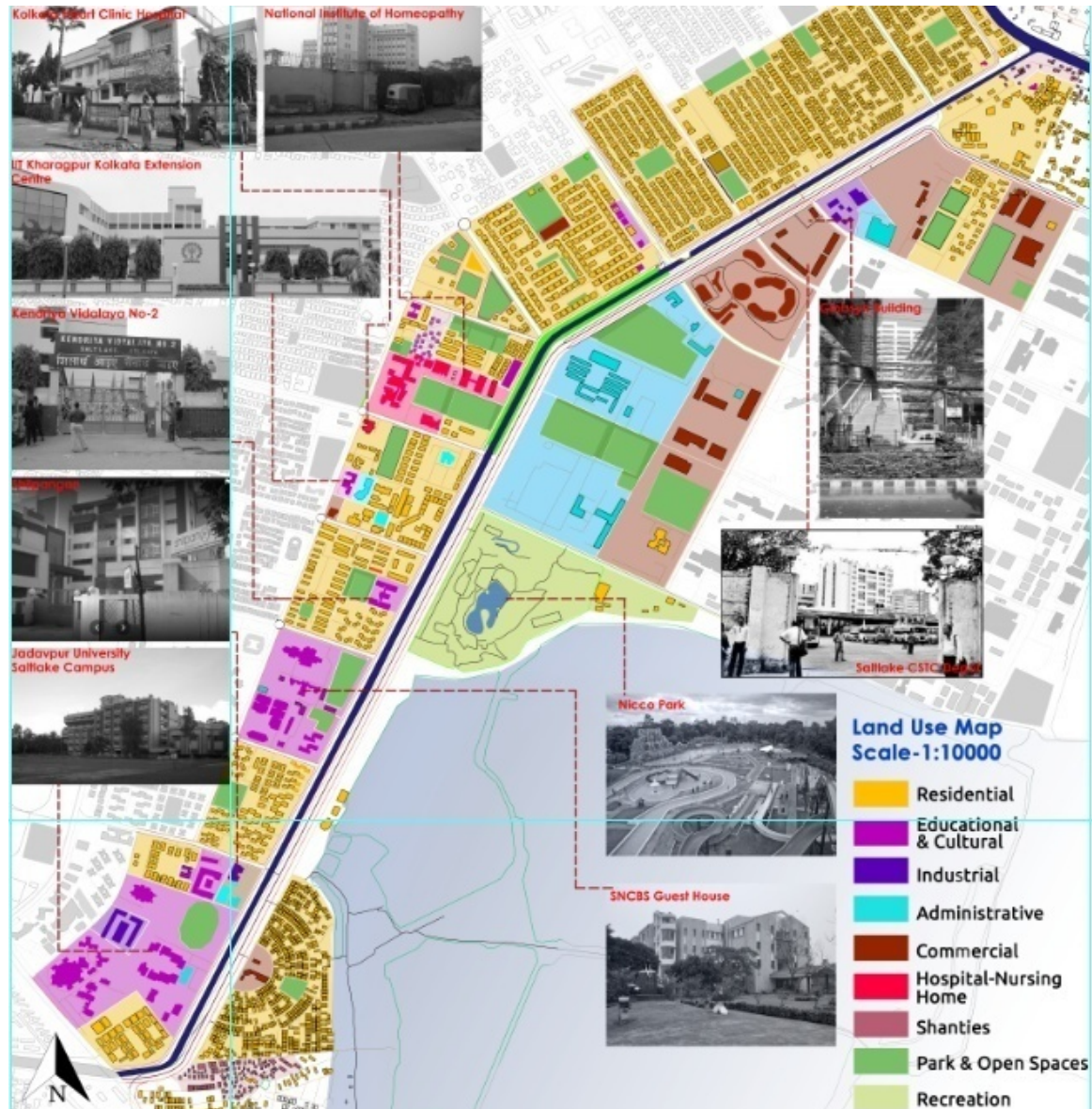
its visual effect, particularly the treatment of paved area (carriageways and footpaths).

5.4.3 Connecting Bridges:

Both sides of the stream are wide enough (20m) to accommodate one-way two-

lane roads, sidewalks and loading/unloading space for smooth traffic flow.4.8 5.5

5.5 Land use



The land use classification of Salt Lake is divided in 4 different parts:-

5.5.1 Institutional Land use towards the Canal

High dense campus may limit the size of an open space and restrict the circulation. So canal corridor can be used as stress relief by different functional activities.



5.5.2 Mixed land use towards the Canal and Wetlands

Social interaction and environmental enhancement reinforced each other to integrate with the wetland community.



5.5.3 Residential Land use towards the Canal



5.5.4 Informal Economy for the Slum Dwellers

Contribution of Squatter settlements towards the economy.



Interdependence Hawkers and Vendors as the eyes on street for a social neighborhood.



Cities will be more livable & will also be a key consideration in Urban Planning if the health of a city & its People are both considered important. Regeneration will help the public to think about Youth Development, Public Health, & Community Building.

CHAPTER-6

6. Data: Analysis



Figure 47: Drying of Ply woods at the canal edges

DATA ANALYSIS

At every 500 m stretch towards the Canal side Road (West Bank) there were Govt Garbage Disposal Site, Vendors at every Nodal Point or Cross Bridge, and at the downstream Plywood's were drying by the local Slum Dwellers.

6.2 Observations



Figure 48: Facing back to the Canal at the Western Edge

6.3 Use of Open Spaces



Figure 51: Spreading wood under the sun



Figure 52: Vegetable Farming for the Living



Figure 50: Barren Edges



Figure 49: Informal Settlements

6.4 Ecology and Habitat



6.4.1 Habitat

Coconut: The tree is having a graceful structure and is also very familiar to saltwater body. The roots have soil nutrients & Phosphate which enrich the ecosystem. Sea birds are most likely passing the coconut architecture grounds. Moreover the iconic trees are dominant along the canal banks.

Bettlenut: They are mostly dominant at some places of the canal, which are cultivated commonly in India. And the leaf is also an invariable element in the homestead garden of the local rural people. Basically used in tradition, custom, or ritual which dates back to thousands of years in Kolkata and all over Kerala, Assam.

Pine: Surprisingly present in the humid climate of Kolkata and is dominant at the canal banks. It is very useful in shading, windbreaks, & screening. Pine branches

have a benefit of soothing sound of wind and have a aromatic fragrance from leaves. Helps in *Soil Erosion control*: The roots helps in holding the soil in place and layer of Pine Needles helping to soften the impact of falling rain. Provide Cover for birds and other small wildlife have drooping foliage allows protection from this Hot and Humid Climate.

Bamboo: Bamboo are most useful in landscape restoration. At the lower stream of the canal have dominance of Bamboo, which creates a sense of enclosure and provide needed shade in summer and also helps to add the biodiversity of the surrounding environment.

Arjun: Were very common in the site. It has a certain roots growing out horizontally into the river bed. But the growth may collapse if the soil gets dry. Usually grow among the stones & mud of the river bed which helps to hold the soil to prevent erosion.

6.5 Existing Issues of the Roads.

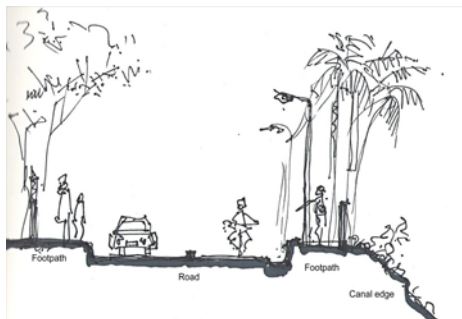


Figure 45: Broken Pedestrian Network, Not Accessible by all

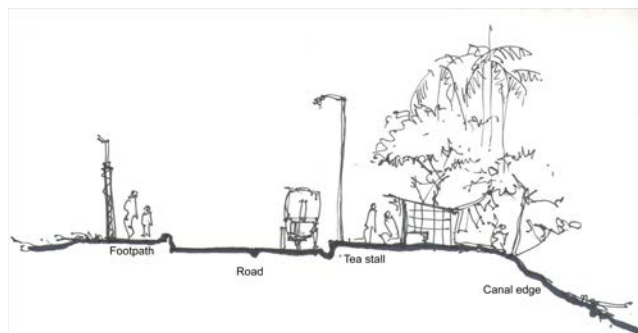


Figure 46: Insanitary & Unhygienic Space becomes backyard

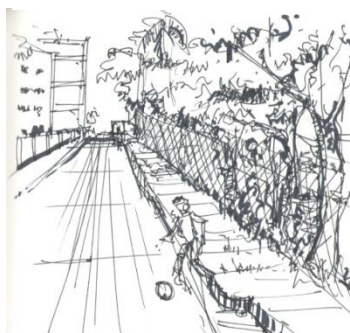


Figure 47: Children's Playing over the Road



Figure 48: Disconnected, People facing their back



Figure 49: Informal Settlements

CHAPTER- 7

7. Proposal Typological Structure for the Canal system of Kolkata

7.1 Design Ideas

Statement between Canal and the City.....Turn the backyard into Front yard.

Facilitating Salt lake Residents to cross the canal and use the sustainable mean of public transit..... Design an experience through landscape, not the journey and increase connectivity between two sides of the canal

Invite forth dimensions in design of the water front (sings of birds, smell of flower)

Introduce water transport in Monsoon (If Possible)

7.2 Design Proposals:

7.2.1 Residential



Food Market:

Designing food market right in front of the housing community helps to prevent mass transportation at the centre of the neighborhood gathering space.

Street Art:

Bank Facade can be used as canvas for authorized street art or Graffiti which influences the culture of Kolkata and also

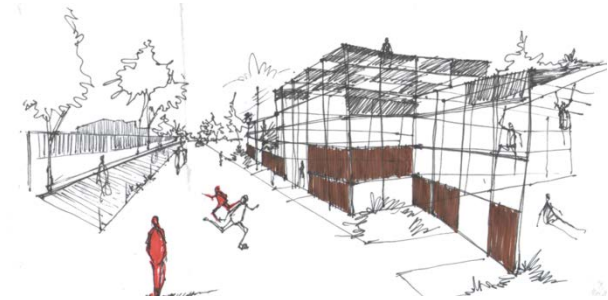


Figure 53: Jungle gym and Play Area



Figure 54: Hawker Zone or Food Market



motivate the public

Children's Play Area:

During site visit there were very limited pocket parks at Sector-5. Children use the road space to play, resulting scope of energetic & imaginative play space design, which may positively influence there behaviors and wider society.

7.2.2 Residential

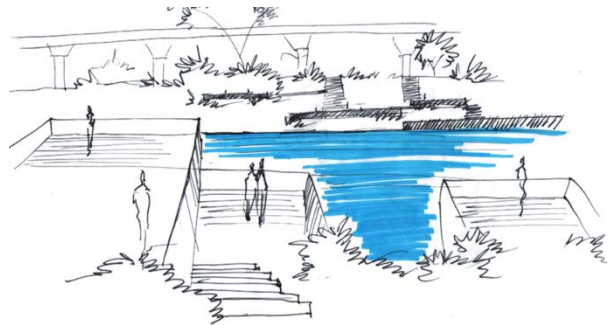


Figure 55: Leveled Viewing Deck

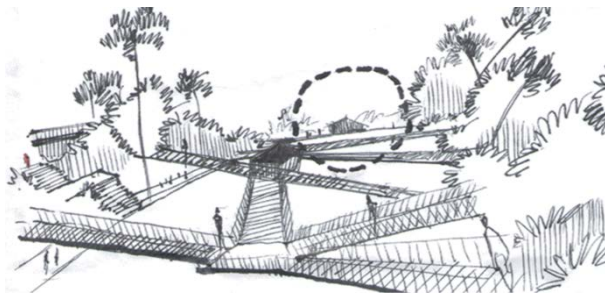


Figure 56: Interconnected Foot Bridge

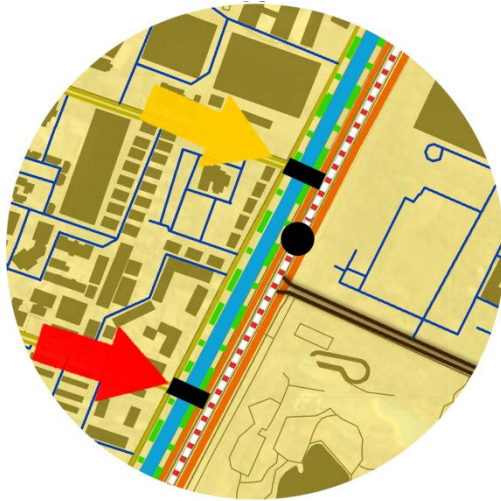
Interconnected Foot Bridge

Foot Bridge is used to walk upon & is slow moving pedestrians i.e. more directly experienced than roads. Foot Bridge should be widening enough with resting pods. Inclusive design for the

physically handicapped, elderly, infants and pregnant woman. The opportunity includes maximizing or framing the views & using street furniture can create attractive environment.

There is an Opportunity to create landmark & to incorporate culture and historic values of the area into the design.

7.2.3 Mixed Use:
Public Plaza



Public Plaza will be designed in a diversity of land use which should attract users from the greater distance. Such kind of plaza should be flexible enough to host lunch crowds, outdoor cafes, passers through, occasional concerts, shows exhibits rallies.

Public art & Sculpture



Figure 57: Multiuse space/Pandals during Festivals

Figure 58: Street Art Installation

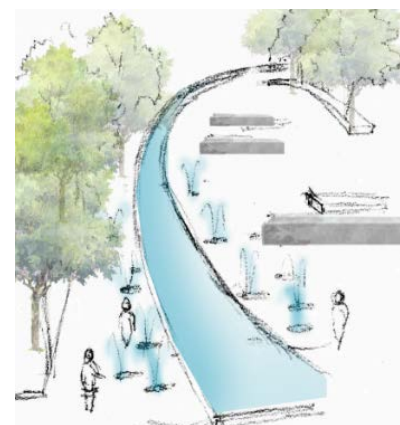
It should make positive contribution which should reflect the city life – Delight, amenity, fantasy, joy, sociability.(Crowhurst, Lennard-1987). We can introduce some market vendors, colorful fabric roof, to draw attention to the family, provide shelter & shade.

Sand Garden:



Figure 60: Space with dirt using Props such as few things, small plastic toys, and stones.

Figure 59: Water Play Space



Water spray can be installed below a rubber surface provide water play for everyone.

7.2.4 Institutional:

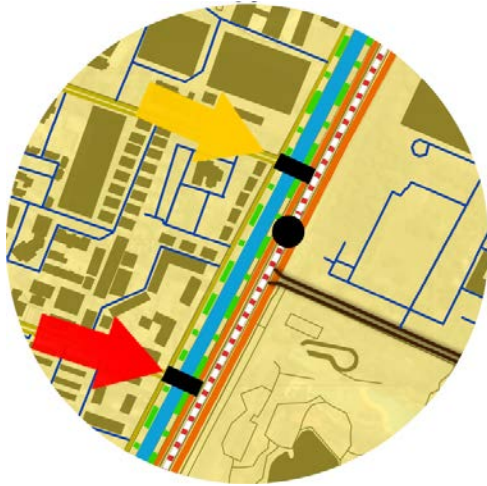


Figure 61: Stepped Lawn

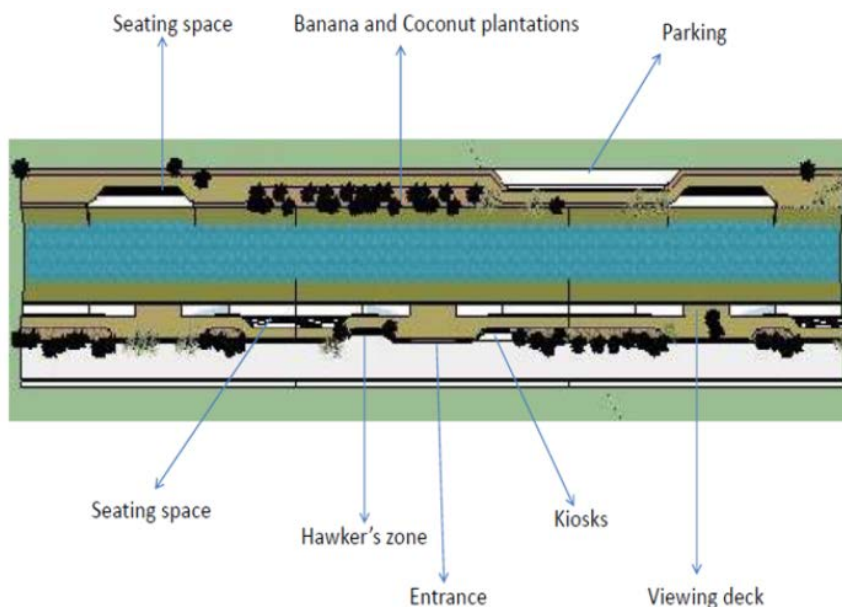


Figure 62: Food Stall, Walking Trail

Linear Space in front of University Campus:

In such case canal front space should have significant habitat, protected areas & connection to the university environment. The space should frame for the space should frame for the faculty, staff, and students as they move at the canal bank. The fabric of outdoor courtyard, gathering space pathways can be useful. In fact in such hot and humid climate, it will create dynamic active spirit to open space.

7.3 Prototype Plan of a Stretch:



7.3.1 Seating:

Seating places should be located in certain shady areas underneath large canopy tree. It also have several secondary seating (mounds, steps with a view, seating walls,

retaining walls, to allow seating).

7.3.2 Vendors:

Vendors and Hawker spaces are specifically designed with platforms with boxes (HT as per need) Kiosk, Designed moving cart.

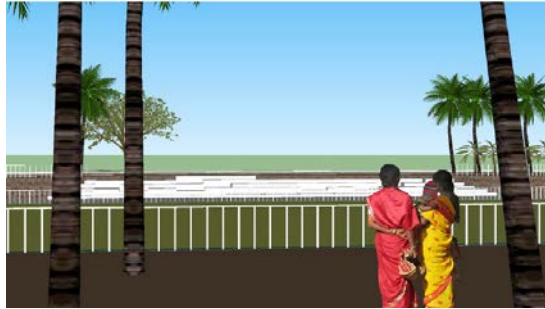


Figure 63: Proposed viewing Deck from Bypass Road



Figure 67: Lower level canal deck

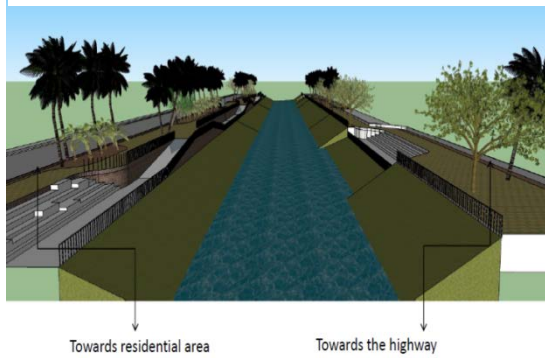


Figure 64: Proposed stepped seating towards the canal front



Figure 65: Pervious Paving and Lower Deck

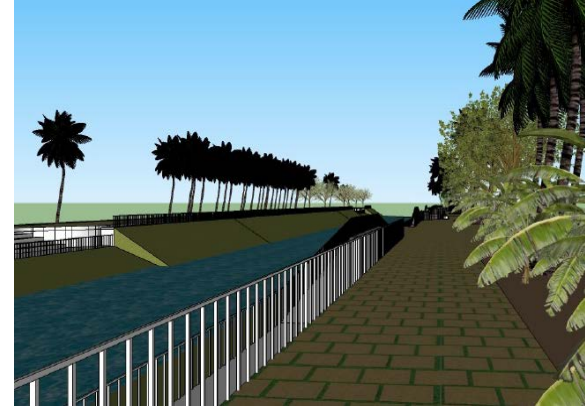


Figure 66: Coconut Grooves and amphitheatre (Other Side)

7.4 Squatter Settlements:

7.4.1 Stakeholder's Aspiration



Figure 68: Vegetable Farming/ Kitchen Garden of their own

PROPOSAL



Need Better Sanitation and potable water supply.

Space for Kids

Less risk of Fire due to temporary building materials.

7.4.2 Small Idea



Re-using of shipping containers for accommodating the Squatter settlements so as to give them a dignified space as well as not interfering with the bond they develop with the canal and also their undeniable service to the local 'Informal Economy'

Painting on the freight container as a part of the urban Arts Commissions. This would also add color and vigor and life to the street.

7.4.3 Prototype -1

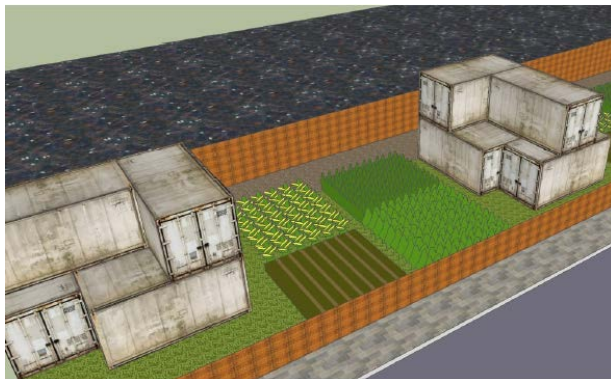


Figure 70: Urban Farming



Figure 69: Waste Segregation

7.5 Sanitation

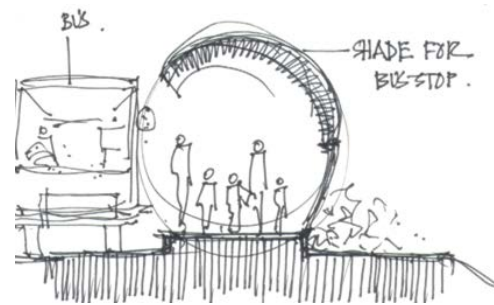
To project the health of individuals, there should be basic provisions of outdoor toilet, drinking water facilities, rest rooms on entire trails and parks to improve the livability of communities and to make life viable.



Figure 71: Public Toilets

7.6 Bus Transit System

At every 500m interval of canal there should be a provision of Bus stop to avoid heavy traffic and the design should impact the street scape/ Design to approve Kolkata Heritage.



7.7 Footpath

There will be a proper continuation of footpath with zebra crossings and Junctions to be provided with pedestrian priority signaling. The underground electrical service and street light shall run along this stretch.



7.8 Parking

Construction of community parking within the canal buffer space at every node and adjacent to connecting bridges which will encourage the public transport and walking.

7.9 Urban Furniture



Figure 74: City Branding



Figure 73: Outdoor work spots



Figure 72: Inflatable Functions

7.10 Organic Farming

Organic farming will provide associate social benefit and productive re-use of urban land. Slum dwellers have harvested for some vegetables to serve for their own, but can be possible for the neighborhood group. This will be inexpensive to implement vegetable farming system.



Figure 75: Urban Farming and Temporary house with Shipping Container

7.11 Termination of Ghats

At every nodal point within 500m improve access and utility of waterfront along the canal. My approach is to conserve the urban heritage at the same time improving the pedestrian experience by zoning & organizing the space in relation to the prevailing activities.

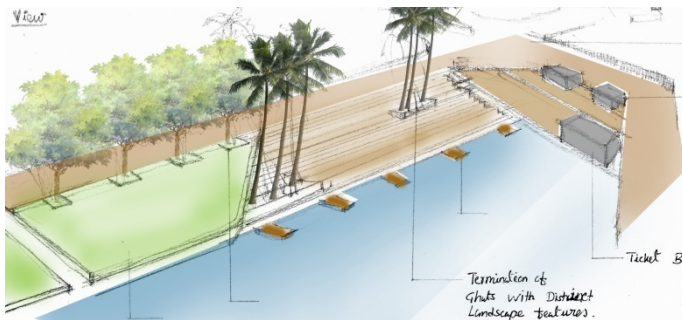


Figure 76: Termination of Ghats with distinct landscape features.

7.12 Bioremediation of Canal Water

Definition: Use of microorganisms (bacteria and fungi) and plants to break down or degrade contaminants. *Requirements:* Available Moisture, Oxygen, Nutrients, Ph, Temperature.

Hammarby Lake City, Stockholm's South island, (Case Study):

Similarity to the site

- a) Need for effective Waste Water Management on the site:-
- b) The implementation of a high-tech waste sorting and waste transportation system
- c) The vacuum waste suction system of various household waste functions (including, for example, burnable and compostable waste).



7.13 Approach for the Funding of Proposals:

7.13.1 Corporate Social Responsibility

As there are many corporate IT offices along the belt abutting Sector 5, CSR is a definitive solution to ask the corporate giants to contribute which would enhance the livability along their belt and would be a great breakout space for their employees.



7.13.2 Crowd Funding

Driving a nominal fund according to the plot size from the owners and funding the project so that the upgrading of the canal front would result in enhanced real estate value in the future. So projecting a buy back for the owners and making them invest in the project is also a possibility.



Figure 77:New York, Central

CONCEPT

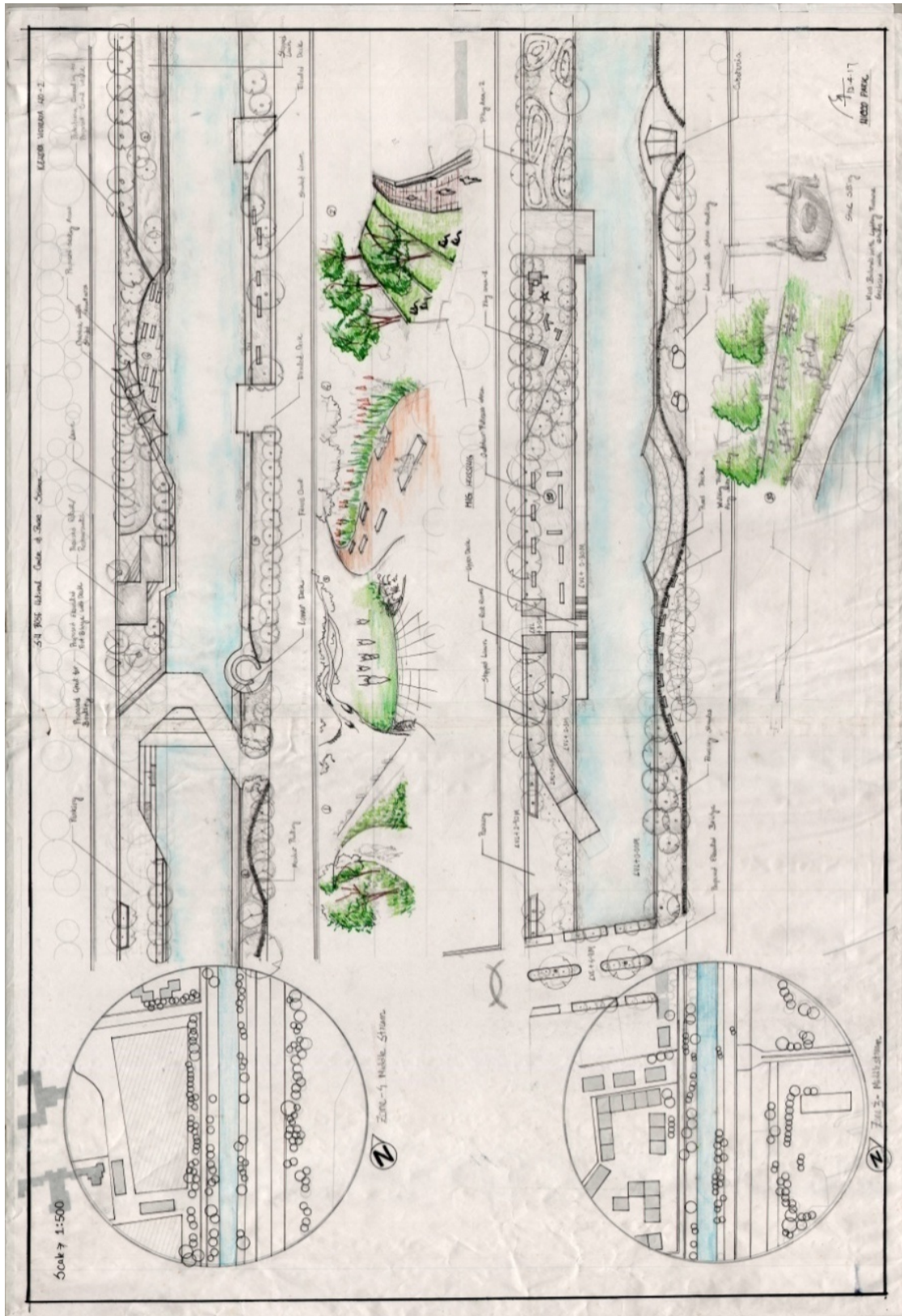


Figure 79: Sheet-2

CONCEPT

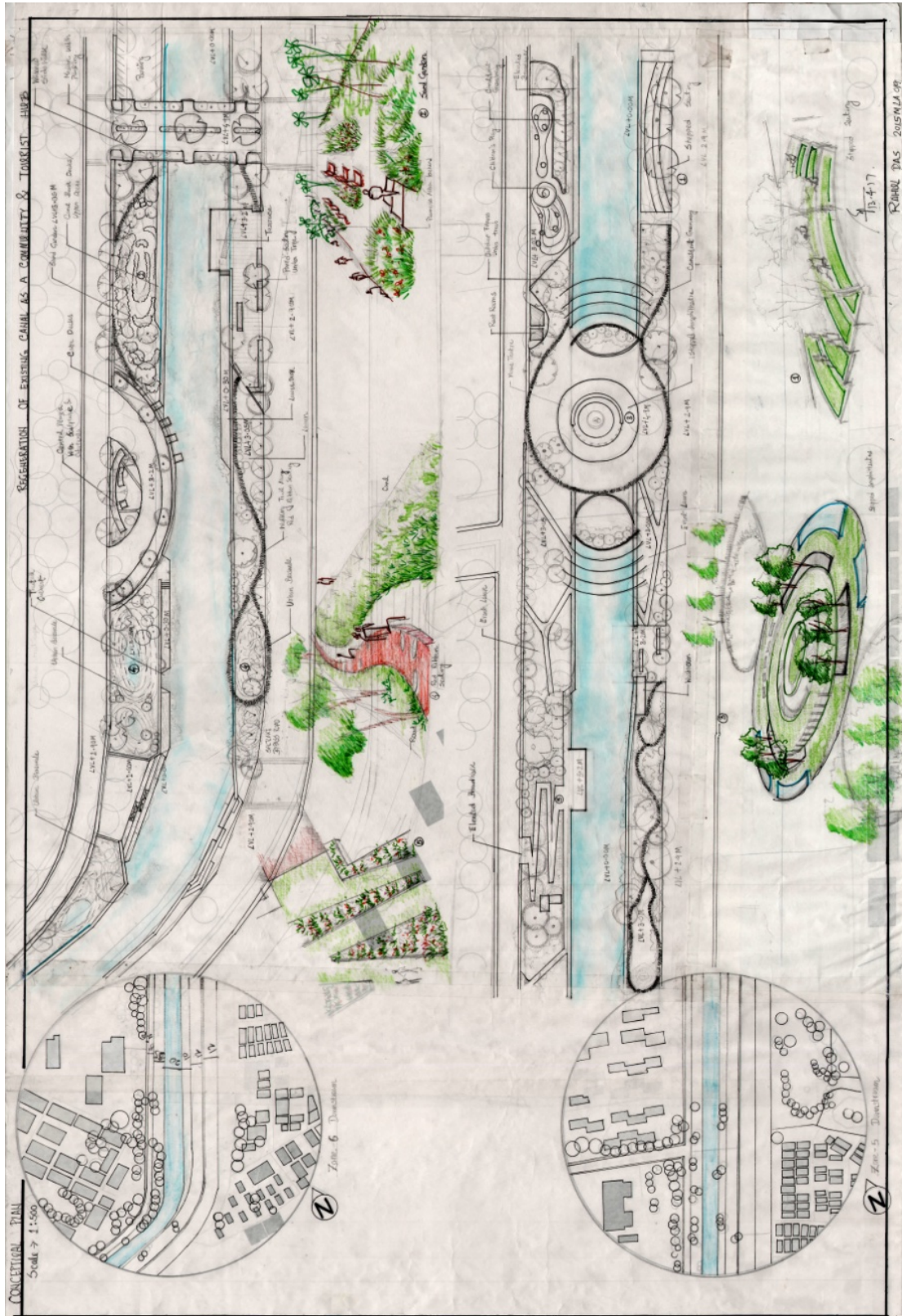


Figure 80: Sheet-3

CHAPTER- 9

9. Design Sheets

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