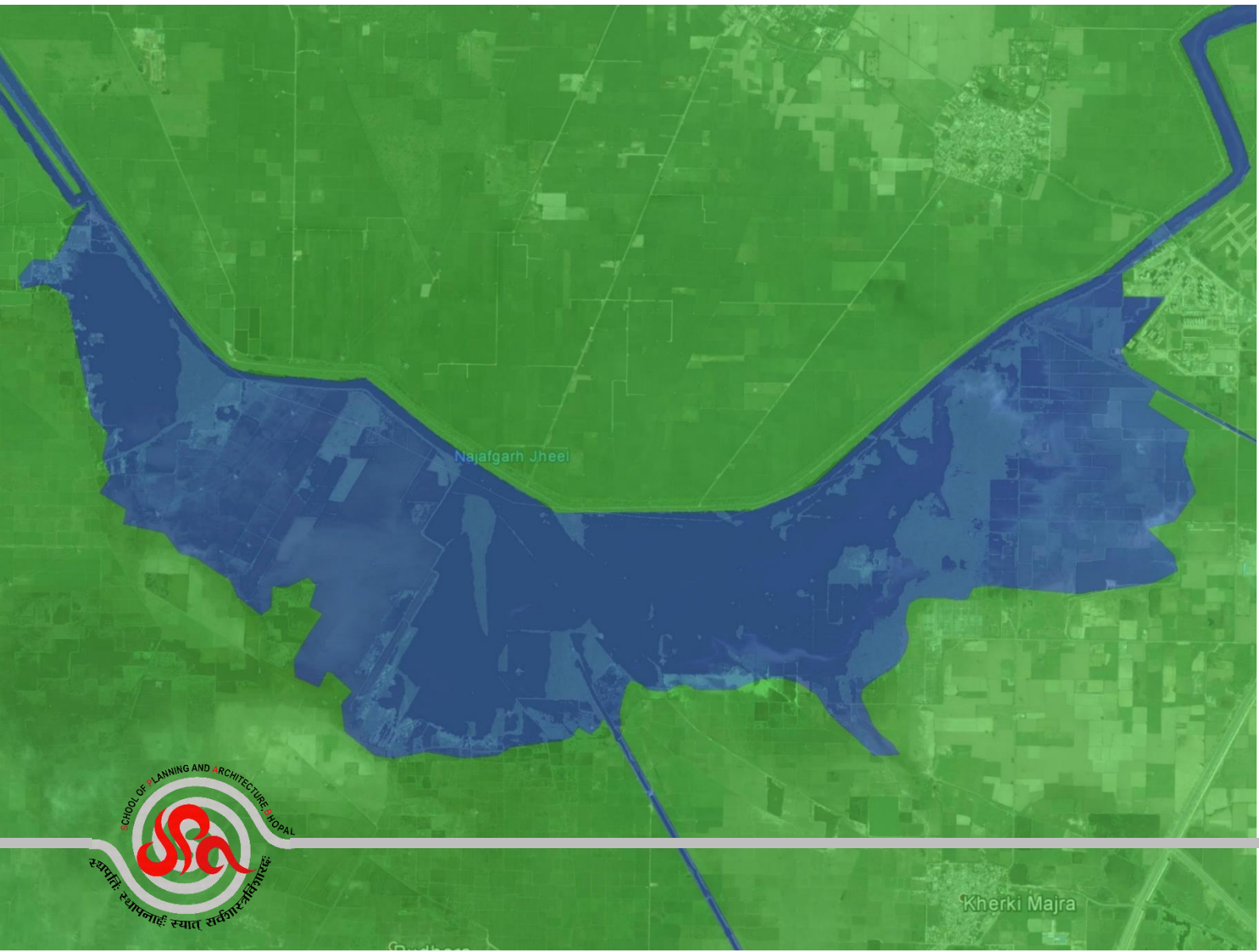


**ECOLOGICAL ASSESSMENT FOR  
ECO-TOURISM DEVELOPMENT PLAN:  
NAJAFGARH BIRD SANCTUARY  
NAJAFGARH JHEEL, DELHI-NCR**

**KUNAL TIWARI**  
2016MLA008  
[2016-2018]



**ECOLOGICAL ASSESSMENT FOR  
ECO-TOURISM DEVELOPMENT PLAN:  
NAJAFGARH BIRD SANCTUARY  
NAJAFGARH JHEEL, DELHI-NCR**

**MASTER OF ARCHITECTURE  
(LANDSCAPE)**

**KUNAL TIWARI**  
2016MLA008



**SCHOOL OF PLANNING AND ARCHITECTURE, BHOPAL  
NEELBAD ROAD, BHOURI, BHOPAL – 462030**

**MAY 2018**

**ECOLOGICAL ASSESSMENT FOR ECO-TOURISM  
DEVELOPMENT PLAN:  
NAJAFGARH BIRD SANCTUARY  
NAJAFGARH JHEEL, DELHI-NCR**

**A DESIGN THESIS**

***Submitted***  
*in partial fulfilment of the requirements for the  
award of the degree of*

**MASTER'S OF LANDSCAPE ARCHITECTURE**

By

**Ar. KUNAL TIWARI**  
2016MLA008

Under the Guidance of  
**Ar. SONAL TIWARI**  
Assistant Professor & Thesis Coordinator



**SCHOOL OF PLANNING AND ARCHITECTURE, BHOPAL**  
**NEELBAD ROAD, BHOURI, BHOPAL – 462030**  
An Institution of National Importance,  
Ministry of Human Resource and Development, Govt. Of India

**Department of Landscape**  
**School of Planning and Architecture, Bhopal**



**DECLARATION**

I, KUNAL TIWARI, Scholar No - 2016MLA008 hereby declare that the thesis entitled “Ecological Assessment for Eco-Tourism Development Plan: Najafgarh Bird Sanctuary, Najafgarh Jheel, Delhi-NCR”; submitted by me in partial fulfilment for the award of *Master of Landscape Architecture* , in School of Planning and Architecture Bhopal, India, is a record of bonafide work carried out by me. The matter embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.

Monday, 30<sup>th</sup> April 2018

**Ar. KUNAL TIWARI**

**CERTIFICATE**

This is to certify that the declaration of “Ecological Assessment for Eco-Tourism Development Plan: Najafgarh Bird Sanctuary, Najafgarh Jheel, Delhi-NCR”; is true to the best of my knowledge and that the student has worked under the guidance of the following panel.

**RECOMMENDED**

Assi. Prof. SONAL TIWARI  
Thesis Coordinator

**ACCEPTED**

Prof. SANJEEV SINGH  
Head of Department  
Department of Landscape Architecture

## ACKNOWLEDGEMENT

I owe a debt of gratitude to Assi. Prof. Sonal Tiwari, Thesis Guide and Thesis Coordinator for the vision and foresight which inspired me to conceive this project. She has been a great teacher, always ready to show the right way to great designs. She welcomed all ideas, imaginations and innovations given and helped in shaping them to get an Ecological, Functional and Experiential Landscape design.

Also, my sincere thanks to Prof. Savita Raje, MANIT, Bhopal for her support and guidance throughout my thesis.

I would like to thank various members of SPA Bhopal:

Asso. Prof. Sourabh Popli, Course Coordinator.

Ar. Shivani Paliwal, for her helpful and fruitful initial inputs.

Prof. Sanjeev Singh, H.O.D., Landscape Department, SPA Bhopal.

Prof. Dr. N. Sridharan, Director, SPA Bhopal.

The Thesis panel for their insights and helpful critics:

Prof. Surinder Suneja, Retired as Dean, SPA Delhi.

Prof. Shishir Raval, MSU, Baroda.

I would also like to mention Environment Executive Astha Srivastava for her constant support on various steps of my study in Environment & Ecology and providing a practical overview.

Last but not the least my blessed family for their emotional support and my friends Steffi Sharma, Jatin Chauhan, Shreshth Vats, Arya Aishwarya, Srishti Rungta and Chaitali Arora for their advice and help.

## ABSTRACT

Wetlands play a very vital role in the environment by creating a unique self-sustaining biodiversity with ecological and environmental significance. They have become a part of day to day livelihood resource and the environment of mankind, they have now become a major concern and highlight of works of many scientists, environmentalists, and many NGOs.

The introduction of wetland to ecotourism site is a very crucial step as it involves various stakeholders and also an integrated network of various benefiteres like the local communities. Ecotourism in a protected area play an important role by establish fruitful and beneficial relationship between the local people the protected area and the biodiversity that it caters to with tourism as a back bone. The delineation of the protected areas require major findings with the help of remote sensing and GIS, this not only helps demarcate a proper boundary but also provides us with essential data of the birds and the health of the wetland and its reach.

Nazahgarh jheel is a large shallow water body, which is located in the south western part of Delhi bordering Gurgaon, the majority of the water logged area lies in Gurgaon and the more than a quarter lies in Delhi. It is part of a tributary to River Yamuna in which it widens here to form a lake and then joins Yamuna immediately after the Wazirabad barrage. It is a home to many migratory bird species and bird watcher tourists. The wetland peripheral zones are cultivated during lean times threatening existing bird populations. It is in a brink of being overpowered by many issues such as encroachment, intensive agriculture etc. This project can create awareness to the locals and help them coexist with the birds that have made this Jheel their winter home.

The main objectives of this study are to explore and examine the ecological character of the wetland and related bird population. To create a conservation master level planning of the area. To study and apply the patterns of vegetation that provides a safe haven to the birds. Lastly to create a proposal for ecological tourism which helps create an awareness to the people residing near the site. The proposal will include strategies to conserve wetland ecosystem.

# CONTENTS

<b>1 CONTEXT .....</b>	<b>1</b>
1.1 Intoduction .....	1
1.2 Aim.....	2
1.3 Objective .....	2
1.4 Methodology .....	2
1.5 Issues .....	4
1.6 Scope and Limitations.....	4
<b>2 LITERATURE STUDY .....</b>	<b>5</b>
2.1 Wetlands.....	5
2.1.1 Wetland Types .....	5
2.1.2 Functions .....	6
2.1.3 Importance .....	6
2.1.4 Threats.....	6
2.2 Ecotourism.....	7
2.2.1 Principles of Ecotourism.....	7
2.2.2 Importance of Ecotourism in India .....	8
2.3 Avifauna.....	9
2.3.1 Bird Ecology .....	9
2.3.2 Bird Habitat .....	10
2.3.3 Types of Habitats for Birds .....	9
2.3.4 How Habitat Loss Affects Birds .....	10
2.3.5 Bird Ecology in India.....	11
Bibliography .....	12
<b>3 STUDY AREA: THE NAJAFGARH JHEEL.....</b>	<b>13</b>
3.1 Habitats of the Najafgarh Jheel.....	13
3.1.1 Deep Water or the Drain Base Level .....	15
3.1.2 The Marshes .....	15
3.1.3 The Above Full Supply Level Zone.....	15
3.1.4 The High Flood Level Zone .....	16
3.1.5 The Riparian Zone.....	16
3.1.6 The Dense Vegetation Zone.....	16

3.1.7 The Farmlands .....	16
3.2 The Need to protect Najafgarh Jheel .....	17
<b>4 SITE ANALYSIS.....</b>	<b>18</b>
4.1 Delineation of Wetland Edge of NBS .....	18
4.2 Climatic Factors .....	19
4.2.1 Rainfall Pattern and Distribution .....	20
4.2.2 Temperature.....	21
4.2.3 Relative Humidity .....	22
4.2.4 Wind Speed and Direction.....	23
4.2.5 Cloudiness .....	24
4.2.6 Water Sources .....	24
4.3 Geology, Rock and Soil .....	25
4.4 Terrain and Topography .....	28
4.5 Landuse Pattern .....	30
4.6 Hydrology.....	34
4.7 Drainage Pattern and River Stream network .....	38
4.8 Water Bodies in Delhi-NCR .....	40
4.8.1 Types of water bodies in Delhi.....	40
4.8.2 Issues in Preservation .....	41
4.9 Site's present scenario.....	42
4.10 Activities In and Around NBS .....	48
4.12 Quantifying the Impact.....	50
Bibliography .....	53
<b>5 FLORA AND FAUNA .....</b>	<b>54</b>
5.1 Birds of NBS .....	54
5.2 Vegetation of NBS .....	59
5.3 Avifauna Habitat Mapping of NBS .....	62
5.4 Migratory Pattern .....	65
Bibliography .....	66
<b>6 CASE STUDY.....</b>	<b>67</b>
6.1 Keoladeo National Park .....	67
6.1.1 About the Park .....	67



6.1.2 Location .....	68
6.1.3 Topography.....	68
6.1.4 Soil.....	68
6.1.5 Climatic Condition .....	68
6.1.6 Rainfall .....	68
6.1.7 Flora and Fauna .....	68
6.1.8 Importance .....	71
6.1.9 Issues.....	71
6.2 Okhla Bird Sanctuary .....	72
6.2.1 About the Park .....	72
6.2.2 Location .....	73
6.2.3 Topography.....	73
6.2.4 Soil.....	73
6.2.5 Climatic Condition .....	73
6.2.6 Rainfall .....	73
6.2.7 Flora and Fauna .....	73
6.2.8 Importance .....	76
6.2.9 Issues.....	76
Bibliography .....	77

## **7 PROPOSAL STRATEGY: LANDSCAPE .....78**

7.1 Statutory Provisions .....	78
7.2 Providing an Identity .....	79
7.2 Boundary Delineation.....	80
7.2.1 The Yearly Cycle .....	81
7.2.1 Normalized Difference Vegetation Index (NDVI).....	85
7.3 Protected Areas & Eco Sensitive Zone in India. ....	88
7.3.1 Protected Areas .....	88
7.3.2 Eco Sensitive Zones (ESZs).....	89
7.3.3 Purpose of ESZs .....	90
7.3.4 Extent of ESZs .....	90
7.3.5 Criteria for Demarcating ESZs.....	91
7.4 Eco Sensitive Zone Najafgarh Bird sanctuary.....	92
7.6 Sustainable Agricultural Practices .....	94
7.7 Water Management .....	94

7.8 Air Pollution Control & Management .....	95
7.9 Soil Conservation & Preservation .....	95
7.10 Noise Control & Management .....	95
7.11 Planting Strategy.....	96
7.11.1 Buffer Planting.....	97
7.11.2 Wetland edges .....	97
7.11.3 Plants inside the sanctuary.....	97
7.11.4 Farmlands .....	98
7.12 Area Demarcation for Recreational Activities.....	99
Bibliography .....	100
<b>8 PROPOSAL: NAJAFGARH BIRD SANCTUARY .....</b>	<b>101</b>
<b>9 CONCLUSION.....</b>	<b>110</b>

# List of Figures

Figure 1: Google image showing location of Najafgarh Jheel.....	1
Figure 2: Images referring the types of wetland.....	5
Figure 3: Map of the geographic regions of India.....	11
Figure 4: Images of site. ....	13
Figure 5: Ecological zones of the Najafgarh Jheel.....	14
Figure 6: Survey of India Toposheet showing natural flow and location of Najafgarh Jheel .....	18
Figure 7: Surface temperature map of Delhi .....	19
Figure 8: Figure showing maximum and minimum rainfall pattern (mm).....	20
Figure 9: Figure showing maximum and minimum temperature (mm) .....	21
Figure 10: Figure showing maximum and minimum Humidity (%) .....	22
Figure 11: Figure showing maximum and minimum Wind Speed (Km/hr) .....	24
Figure 12: Bhuvan map showing the geomorphology of the area. ....	26
Figure 13: Bhuvan map showing the Ground Water Prospect of the area. ....	27
Figure 14: Bhuvan map showing the Terrain of the area. ....	29
Figure 15: DDA’s Delhi master plan with defined Landuse of the site .....	30
Figure 16: GDA’s Gurgaon-Manesar master plan with defined Landuse of the site .....	31
Figure 17: DDA’s L-Zone master plan demarcating the extent of the Najafgarh Jheel. ....	32
Figure 18: Bhuvan map showing the LULC Map of the area.....	33
Figure 19: Graphical Representation of Sahibi River from watershed to basin .....	34
Figure 20: India WRIS image of Yamuna upper sub basin. ....	35
Figure 21: Drainage map of Delhi by IFCD, Govt. of Delhi, showing the Najafgarh drain. ....	36
Figure 22: The seasonal variations in the water spread of the wetland. ....	37
Figure 23: Stream order map with green patch depicting the Stream Corridor. ....	38
Figure 24: Surface drainage pattern of the area surrounding the Jheel.....	39
Figure 25: Google Earth image of the site with (1X1)sqkm grid .....	42
Figure 26: Site images in grid G1.....	43
Figure 27: Site images in grid G2.....	43
Figure 28: Site images in grid F2 .....	44
Figure 29: Site images in grid E3 .....	44
Figure 30: Site images in grid D3.....	45
Figure 31: Site images in grid C2.....	45
Figure 32: Site images in grid B1.....	46
Figure 33: Site images in grid A1.....	46
Figure 34: Site images near the Sahibi river entering Delhi.....	46

Figure 35: Existing site sections. ....	47
Figure 36: Avi-Fauna Habitat map of the Najafgarh Jheel. ....	64
Figure 37: Bird life international image showing the central Asian flyway. ....	65
Figure 38: Google earth image of the Keoladeo National Park. ....	67
Figure 39: Photographs of some of the birds and animals in the park.....	69
Figure 40: Bird watchers guide to India’s plan of the national park.....	70
Figure 41: Photographs of the National park.....	71
Figure 42: Google earth image of the Okhla Bird Sanctuary. ....	72
Figure 43: OBS website’s Photographs of some of the birds and animals in the park. ....	74
Figure 44: Trimble data’s plan of the Okhla Bird Sanctuary. ....	75
Figure 45: Photographs of the National park.....	76
Figure 46: Proposed Logo for Najafgarh Bird Sanctuary.....	79
Figure 47: Google Earth image depicts the extent of water during post-monsoons in year 2016.....	81
Figure 48: Google Earth image depicts the extent of water during pre-winters in year 2016.....	81
Figure 49: Google Earth image depicts the extent of water during peak-winters in year 2016. ....	82
Figure 50: Google Earth image depicts the extent of water during late-winters in year 2017. ....	82
Figure 51: Google Earth image depicts the extent of water during springs in year 2017. ....	83
Figure 52: Google Earth image depicts the extent of water during peak-summers in year 2017.....	83
Figure 53: Google Earth image depicts the extent of water post-monsoon in year 2017. ....	84
Figure 54: The NDVI map of February 2017.....	85
Figure 55: The NDVI map of May 2017. ....	85
Figure 56: The NDVI map of September 2017. ....	86
Figure 57: The NDVI map of December 2017. ....	86
Figure 58: Overlapped NDVI Maps to show the variations. ....	87
Figure 59: Figure showing proposal of ESZ boundary of Najafgarh Bird Sanctuary ....	92
Figure 60: Figure showing ESZ boundary of Okhla Bird Sanctuary defined by MOEF&CC ....	93
Figure 61: Figure showing ESZ boundary of Asola Bhatti Wildlife Sanctuary defined by MOEF&CC ...	93
Figure 62: Proposal Strategy for Najafgarh Bird Sanctuary. ....	101
Figure 63: Proposed Zoning. ....	102
Figure 64: Proposed Activity Mapping.....	103
Figure 65: Vegetation Cover. ....	104
Figure 66: Water Extent. ....	105
Figure 67: Proposed Master Plan of Najafgarh Bird Sanctuary. ....	106
Figure 68: Sections of Proposed Master Plan of Najafgarh Bird Sanctuary.....	107
Figure 69: Sections of Proposed Master Plan of Najafgarh Bird Sanctuary.....	108
Figure 70: Proposed Planting strategy to be followed throughout the site. ....	109

## List of Tables

Table 1: Rainfall Record (mm) from year 2002-2013.....	20
Table 2: Temperature Record (°C) from year 2002-2013 .....	21
Table 3: Humidity Record (%) from year 2002-2013 .....	22
Table 4: Wind Speed (Km/hr) from year 2002-2013.....	23
Table 5: Wind Directin from year 2002-2013 .....	24
Table 6: Wind Speed from year 2002-2013 .....	41
Table 7: Activities with their applications.....	48
Table 8: rating for the matrix.....	50
Table 9: Axis .....	50
Table 10: Evaluation of the Environmental Element. ....	52
Table 11: Najafgarh Jheel Birds list with their IUCN red listing. ....	54
Table 12: Existing Vegetation at NBS.....	59
Table 13: Proposed Vegetation at NBS.....	61
Table 14: Ecological habitats with Birds found at that zone in NBS .....	62

# 1 CONTEXT

## 1.1 Introduction

Nazahgarh Jheel is a large shallow inland wetland, located in south western part of Delhi bordering Gurugram, the majority of water logged area lies in Gurugram and the more than a quarter lies in Delhi. The part is continuation of Sahibi River that collectively forms the elongated water body that is the Nazagarh jheel. It is a tributary to River Yamuna in which it widens here to form a wetland and then joins Yamuna immediately after the Wazirabad barrage. The lake is a refuge to thousands of migratory waterbirds every winter due to the increase in the water levels after the monsoons which recedes till winter end. The winter months is the best time to visit it to see many flocks of winter migratory waterbirds. NAJAFGARH JHEEL AND DRAIN is currently classified as M.P. Green area Najafgarh Drain, Afforestation M.P. Green Area Najafgarh Drain and Chhawla or Najafgarh drain city forest.

**IMPORTANCE OF THE JHEEL:** Besides being a generous host to vast bird population the drain is into work as being a beneficial asset to the urban agglomeration of Delhi-NCR. The Jheel is one of the largest surface water body in the region and this surface body works as natural water treatment plant for the drain that connects from Gurugram. The ground water table of the area is also maintained as the Jheel is also one of the largest contributor to this cause.

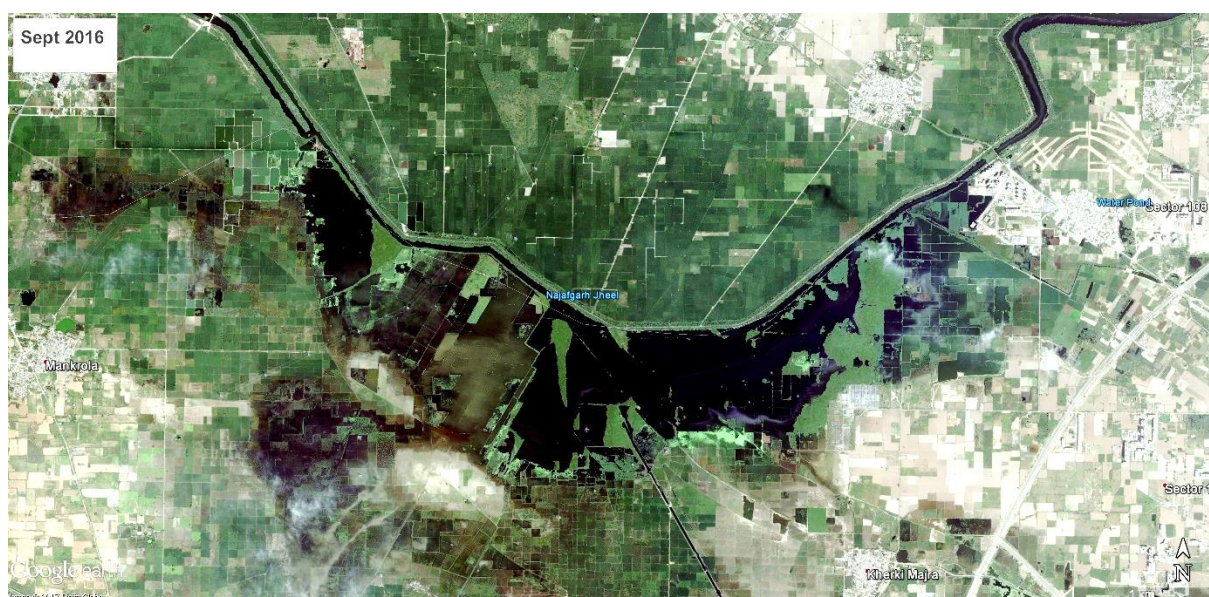


Figure 1: Google image showing location of Najafgarh Jheel

## **1.2 Aim**

### **Ecological Assessment for Eco-Tourism Development Plan: Najafgarh Bird Sanctuary, Najafgarh Jheel, Delhi-NCR**

## **1.3 Objective**

The main objectives of this study will be-

- To understand the ecology of the wetland.
- To determine ecological boundary of the Najafgarh Bird Sanctuary.
- To identify the threats and issues
- To prepare a master plan for ecotourism development.
- To study and propose planting strategies which enhance bird population in the bird sanctuary and the surrounding areas.
- To identify land suitable for ecotourism and educational area.

The proposal is a conservation plan for Najafgarh Bird Sanctuary.

## **1.4 Methodology**

The study is based on collection of data from different sources, categorically the data is collected as,

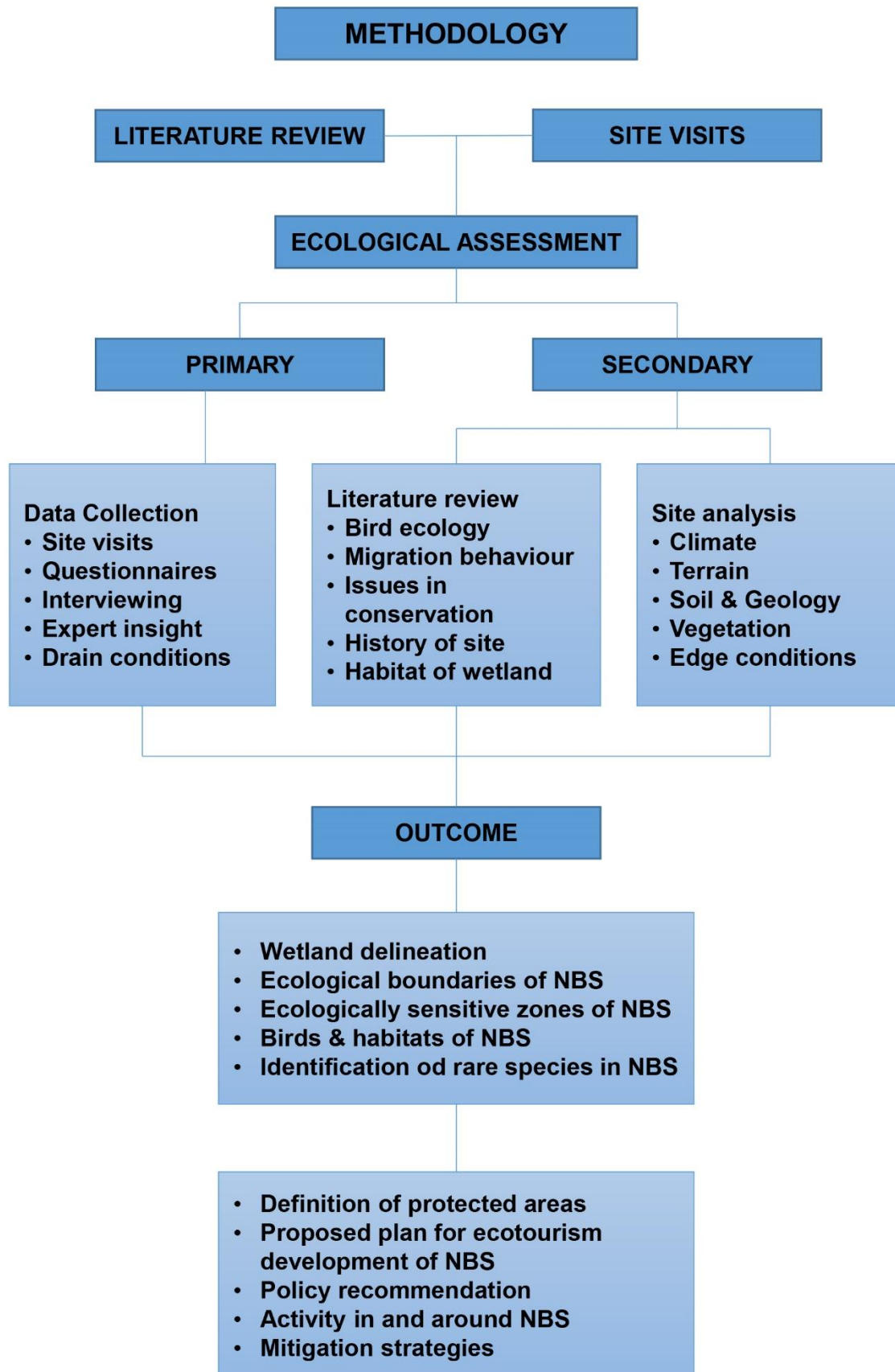
- The primary data, and
- The secondary data

These data has been collected from various sources such as journals, books, internet and other published and unpublished works.

**Parameters** to be kept while going forth the study will be,

- Qualitative Parameters, and
- Quantitative parameters.







## **1.5 Issues**

Like many wetlands throughout the country and world, the Nazafgarh Jheel is in a brink of being overpowered by many issues that this paradise faces, the most powerful among them is political agenda where the area is being threatened by the real-estate market and Gurugram government never notified the area under a water body until February of 2017 after a constant notification by INTACH and other NGOs.

The linear infrastructures such as high voltage power lines are nearly invisible to birds in flight which can result in collisions and subsequent loss of life. With the yearly siltation the area is rich in nutrients and provides great hydrophilic soil for great crop yield which results in illegal encroachments of the land for farming, where the use of pesticides and other chemicals for farming can lead to polluting of the lake during the monsoons as the chemicals wash of during rains in storm water and accumulates in the lake. The other issues relate to the urbanization with it increase in vehicular movements, air pollution and increase in solid waste disposal.

## **1.6 Scope and Limitations**

The main focus of this thesis is to delineate the boundary of the sanctuary with the help of latest graphical tools and to identify the zones in the in the NBS which caters to the biodiversity of this area. The main focus to conserve the ecology of the area will be by retaining the water level to provide a better edge conditions for the waterfowls and other birds alike, this can be done by providing better and improvd drainage system to the area regarding the outflow of several drains and from the nearby farmlands that fall under the ESZ surrounding the NBS.

Provide a planting strategy to reinvigorate the present scenario and provide hideouts to the birds for breeding and roosting whilst providing buffers around the site to ensure any external disturbances.

Nature without balance is never thought of and with growing human population a better ecosystem that is suitable for both birds and humans has to be maintained and create awareness in terms of the sensitivity of the situation related to the current pattern of various birds habitat in an urban area.

## 2 LITERATURE STUDY

### 2.1 Wetlands

According to Ramsar Convention, Wetlands are defined as, the “Areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres”. (Convention, 2004)

#### 2.1.1 Wetland Types

Every country in the world have a wetland of some or the other typology, some are seasonally aquatic and some are seasonally terrestrial. Some of the type of wetlands include;

- Marine – coastal lagoons, coral reefs, Seagrass beds and rocky shores.
- Estuarine – mangrove swamps, tidal marshes and deltas
- Lacustrine – along lakes
- Riverine – along rivers and streams
- Palustrine (Marshy) – marshes, bogs, and swamps.



Figure 2: Images referring the types of wetland.

### **2.1.2 Functions**

There are numerous functions that are performed by wetlands such as:

- Recycling of nutrients
- Purification of water,
- It helps in attenuating the flood level
- Also Maintains the stream flow,
- Helps in Recharging the groundwater,
- Provides drinking water,
- Maintains the wildlife habitat
- Control the rate of runoff along with creating the buffer shorelines against erosion

### **2.1.3 Importance**

Wetlands are classified as one of the most threatened habitats of the world due to progressive increase in anthropogenic activities. There are various causes for a significant deterioration of wetland resources. These activities include threats from industrial, agricultural and various urban developments. These activities have led to hydrological disturbances and pollution.

### **2.1.4 Threats**

The loss of wetland leads to imbalance in the way the environment and nature works which leads to ecological problems, this directly impact the socio-economic benefits of the people.

## 2.2 Ecotourism

According to the World Conservation Union (IUCN), the Ecotourism is defined as:

*"Environmentally responsible travel to natural areas, in order to enjoy and appreciate nature (and accompanying cultural features, both past and present) that promote conservation, have a low visitor impact and provide for beneficially active socio-economic involvement of local peoples."*

Ecotourism is maintaining the tourism in natural areas without compromising the need of conserving the environment and making it more sustainable.

As per The International Ecotourism Society,

*"Ecotourism is now defined as "responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education" (TIES, 2015). Education is meant to be inclusive of both staff and guests."*

### 2.2.1 Principles of Ecotourism

- Ecotourism should be environmental friendly and socially and culturally responsible.
- It is about uniting the communities in order to minimize the negative impacts on environment and make the tourism sustainable.
- Providing economic benefits for the local communities involved, by introducing the alternative employment and other direct income opportunities.
- Creating public awareness about the need to protect and conserve the environment and respecting the local culture.
- Introducing the alternative, low impact and environment friendly facilities.



### **2.2.2 Importance of Ecotourism in India**

India being a reserve country of natural beauty like mountains, oceans, natural forests, valleys, architectural monuments and archaeological sites offers various tourism options all across the country. Tourism in India due to its varied geography is classified into four major parts:

- a) North Indian Tourism,
- b) West India Tourism
- c) South Indian Tourism
- d) East Indian Tourism

Each part offers several different tourist destinations to enjoy the nature in the most pristine way.

Presently, tourism is one of the largest service industries in India. The GDP of the country is expected to grow at the rate of approximately 8.0 percent yearly in the period of 2013-2023.

The WTO and UNEP (United Nations Environment Program) recognize five key challenges for sustainable tourism and they are: -

- Managing the progressive increase in the growth rate of international tourist arrivals by 2020.
- Climate change, as increase in tourism will contribute more towards the global warming.
- Poverty abatement mainly in rural areas where tourism can provide only a small number of augmentation options.
- Support from tourists regarding conserving and protecting the environment; and
- Issues regarding health and safety of tourists.

## 2.3 Avifauna

### 2.3.1 Bird Ecology

Ecology is defined as the relationship of organisms with each other and to their physical environment that surrounds them. The balance between birds and other organisms is very delicate as the effects of any change is never restricted to single species but can affect the entire ecology balance and food chain.

The ecology of birds suggests their behaviour in the particular environment as how they coexist with other organisms.

There are two main aspects of ecology of birds.

**1) Feeding Ecology:** There are variety of food that are preferred by birds. E.g. Flowers, berries, seeds, nectars, fish, worm, crab, mouse, reptiles or even another bird. The type of food preferences can be easily identified by the shape of the bird's beak. Birds are able to exists in the same habitats by having different food preferences and not compete with one another for food.

#### **2) Breeding Ecology:**

Birds require a place to build a nest, they need enough food for themselves and their young. Moreover, they also need to protect their young from predators or other sources of danger.

#### **Season-**

The breeding time of a bird depends on the favourable chances of their offspring to survive. It generally coincides with the time period when food is abundant.

### 2.3.3 Types of Habitats for Birds

There are different types of habitats which support different types of birds and other wildlife. These habitats include forests, grasslands, wetlands, deserts, oceans, tundra, urban and suburban

### **2.3.2 Bird Habitat**

A bird requires food, water, nesting sites and shelter for its survival. These may differ according to the different types of species.

- Food includes fruits, grains, seeds, nectar-producing flowers, nuts, insects, fish, reptiles and other birds.
- Water: Any source available for drinking or bathing, including rivers, swamps, lakes, streams and oceans.
- Shelter: tree canopy of deciduous trees or coniferous trees, shrubbery, caves or rock niches, overhanging banks or snags.
- Nesting Sites: Hollow trees or snags, burrows, nesting boxes, bird houses, vegetation to support nests and suitable nesting material.

Seasonal change of habitats by birds is termed as migration. It may occur by switching between two different habitats or two similar habitats that may be far from one another or in different locations.

### **2.3.4 How Habitat Loss Affects Birds**

Habitat destruction and fragmentation are the major threats for the birds. The activities that may impact habitat includes:

- Transforming natural habitats by clearing the fields for agricultural use
- Logging and forest harvesting for fuel, fodder or wood that removes mature vegetation
- Modernization of urban areas that may include development of houses, industries, roads, wind turbines or any other similar activities.
- Climate change is also one of the reason of habitat loss.
- Polluting activities such as mining, oil runoffs etc also damage the habitats.
- Natural disasters can also damage habitats though likelihood of such events is less but these events are also considered for the habitat loss.

In order to survive, every organism have to adapt to the changes. Birds in the similar manner can also adapt to the changes in habitat over the period of time and may shift to more suitable locations. In some cases, changes in the habitat may even be beneficial and can encourage the growth of plants that may support different bird species.



### 2.3.5 Bird Ecology in India

India with over 1301 variety of species (Clements, 5th ed.) makes itself one of the richest bird areas in the world with around 14% of the world's birds.

India lies between three biogeographic zones- Indo-Malayan, Afro-tropical and Palearctic which makes India surprisingly rich in avifauna and this can be attributed because of the diversity in the topography, habitats and climate zones. Thus, this makes India, a paradise for bird watching.

The Indian birds are categorized into 25 groups called 'Orders', which are further sub-categorized into 'Families', 'Sub-families' and 'Genera'.

In India 13 bio-geographical regions can be demarcated as per Bird ecology:

Trans Himalayan,

- Western Himalayas,
- Eastern Himalayas,
- Desert,
- Semi-arid,
- Gangetic plain,
- Central India,
- Deccan Plateau,
- Western Ghats,
- Eastern Ghats,
- North East,
- Coasts,
- Lakshwadeep islands, and
- The Andaman Nicobar Islands.

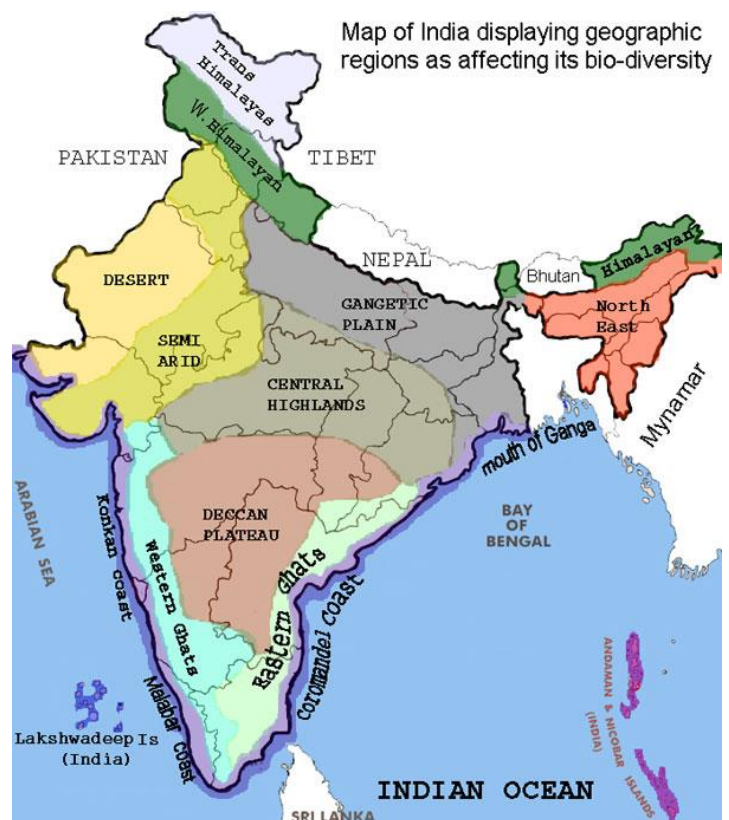


Figure 3: Map of the geographic regions of India.



## Bibliography

- Jianying Xu , Yihe Lü , Liding Chen & Yang Liu (2009) Contribution of tourism development to protected area management: local stakeholder perspectives, *International Journal of Sustainable Development & World Ecology*.
- Guidelines for Ecotourism In and Around Protected Areas (2011), Ministry Of Environment and Forestry, Govt.Of India.
- Aggarwal Prateek, *International Tourism*. Reference Press, Delhi (1991)
- A.K. Bhatia, *Tourism Development - Principles and Practices*. Sterling Publishers Private Ltd., New Delhi (1995)
- Aneja Puneet, "Tourism Growth in India". *Kurukshetra*, Vol.17, No.9, June 2005
- Awadh Singhal, Agarwal Meera, *Glimpses of Tourism in India*. Kanishka Publishers and Distributors, New Delhi (1985)
- Butler Richard, W. & Stephen, W. Boyd, *Tourism and the National Parks, Issues and Implications*. John Wiley and Sons Ltd., Singapore (2000)
- Chaturvedi Devesh, "Tourism in India: Ensuring Buoyancy and Sustainability". *Yojana*, Vol.13, No.8, May 2010
- D.S. Bharadwaj, & O.P. Kandari, *Domestic Tourism in India*, Indus Publishing Company, Delhi (1999)
- [www.indiawildlifeportal.com](http://www.indiawildlifeportal.com)
- [www.indiatourismstate.com](http://www.indiatourismstate.com)
- [www.tourisminindia.com](http://www.tourisminindia.com)
- [www.tourism.gov.in](http://www.tourism.gov.in)
- [www.ecotourismindia.com](http://www.ecotourismindia.com)
- [www.indianaturetours.com](http://www.indianaturetours.com)
- [www.birds.cornell.edu/clementschecklist/](http://www.birds.cornell.edu/clementschecklist/)



### 3 STUDY AREA: THE NAJAFGARH JHEEL

#### 3.1 Habitats of the Najafgarh Jheel

The Najafgahr Jheel is a seasonal inland wetland which when observed during the months of monsoon till the end of winters shows different habitats and zones where birds visit. The site consists of zones that varies seasonally depending upon the level of water present, after thorough observations using various graphical data and tools, understanding the nature of the topography, satellite images of all the months and site visits in various months, the site is zoned into various types of habitat.



Figure 4: Images of site.

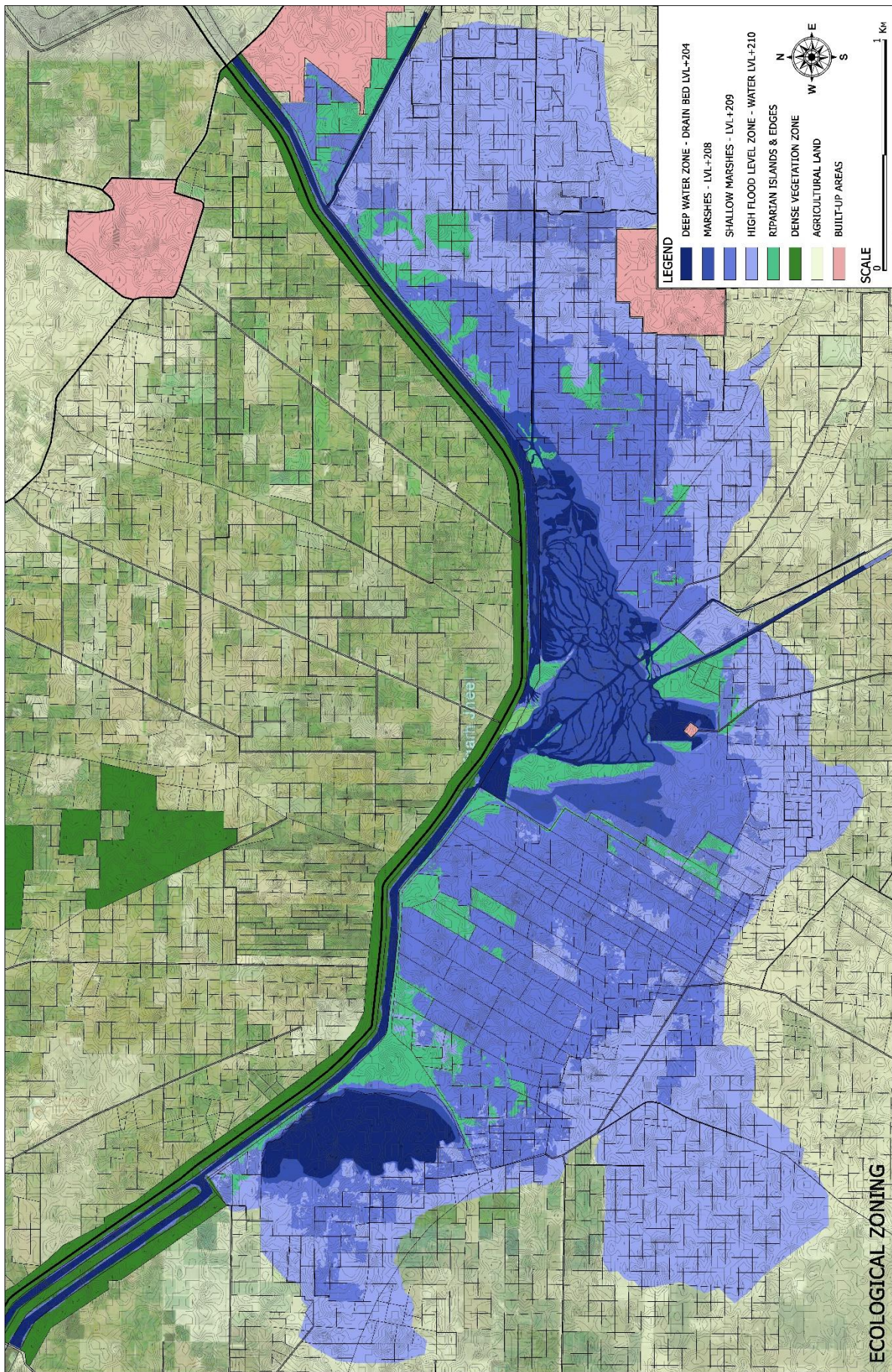


Figure 5: Ecological zones of the Najafgarh Jheel



### **3.1.1 Deep Water or the Drain Base Level**

This is the zone which attracts many waterfowls and other species that depend on the deep waters, the zone does not have any particular over surface vegetation other than the water hyacinth but is a feeding area because of various fishes and under water vegetation.

This zone consist of the main drain channel and the veins formed by the Gurugram drain which cuts its path through the marsh to connect to the drain.

The water in this zone remains throughout the year and when the drains tends to lose its water during harsh summer water from the nearby canal is directed to flow through the river in intervals for the nearby farmlands.

### **3.1.2 The Marshes**

This area is the major attraction part of the wetland as it sustains majority of the bird population, the dancing ballerinas are spotted in this area, the greater flamingos prefer 6"-9" of water as their main food is the algae which grow in abundance in this part.

Various other birds depend on this area for their food as hydrophilic vegetation is in great quantity here and nearby hideouts provide shelter form prey, even the main food for them, the insects and worms and fishes are also available in this zone.

The marshes are under water for 2-3 months and then the submerged vegetation make way to the surface, which in turn is eaten by the birds.

### **3.1.3 The Above Full Supply Level Zone**

This zone is formed immediately after the monsoons when the extra water runs quickly into the drain and the majority of the site is filled with 6"-9" of water, this provides home to various edges species and shallow water birds and field birds.

The area during winters is the major attracting for some species as it generates new vegetation which provide food for the birds and insects.



### **3.1.4 The High Flood Level Zone**

This is the level of water during the peak of monsoon when every part of the site is either wet or under a thin blanket of water. And also this hydrophilic soil become rich in nutrients and fertilized that is it then used for agriculture.

The extent of this zone also helps determining the boundary of the site.

### **3.1.5 The Riparian Zone**

This is prominently found near the marshes and deep water level zone, the riparian in this site gets 50 submerged during the monsoon and also by the FSL zone.

This zone provides a perfect hideout for the waterfowls and also becomes breeding ground for many. And also caters large population of insects.

### **3.1.6 The Dense Vegetation Zone**

This is only found near the inspection road as they were planted after the channeling was done, the dominated by babool trees, various shrubs and seasonal vegetation come to life during the rainy seasons.

The area is home to pheasant birds and various ground and tree loving birds.

Spotted owl is the species which always seek this zone for shelter.

### **3.1.7 The Farmlands**

The northern and later the croplands exposed in time are home to many field birds like sarus cranes and common cranes.

Kites and Eagles also roam around these lands in search of various rodents.



### **3.2 The Need to protect Najafgarh Jheel**

According to AWC 2018 census, there has been an increase in water bird's diversity at the Jheel. Birds were majorly reported to be seen during late mornings rather than afternoons. This depicts that Najafgarh is an important feeding habitat for birds, especially for geese, as the species are vegetarian. But Najafgarh Jheel is shrinking due to less monsoon rainfall in 2017 thus, requires immediate action by authorities to protect.

Even after less rainfall, better species diversity was recorded this year, not many duck species were spotted but small flocks of Common Teal have been recorded. This is because of lack of water in the wetland. Moreover, birds don't find Najafgarh Jheel to be a safe place to reside as they are coming only to feed. They might be residing in nearby wetlands, including Okhla Bird Sanctuary and Sultanpur National Park. Thus, it calls for an immediate notification of Najafgarh Jheel as a wetland and measures for its protection.

With a new bird sanctuary coming up in the national capital region the natural insight of people's awareness towards nature and many other factors related to sensitive ecosystems and the harm that are caused by human activities can come to light.

These types of projects always help in maintaining an ecological balance between man and nature, and their buffer zones provide a healthy relation between the two. In this world of ever growing human activities, we play a major role in both destroying as well as maintaining the ecological balance that can provide a shelter and habitat for the wonderful species that in near future are going to be another Siberian crane story.

The Najafgarh Jheel which is now home to many migratory bird species is also just a remainder of a large patch of a lake turned to wetland which is in ever growing danger of being completely turned into a farmland. This project can create awareness to the locals and help them coexist with the birds that have made this Jheel their winter home.



## 4 SITE ANALYSIS

### 4.1 Delineation of Wetland Edge of NBS

The NBS falls under the administration of Delhi and Gurugram, the Sahibi River enters Delhi at Dhansa Barrage and when it converges back to the border areas it opens up in a large shallow water body which forms a wetland biodiversity ultimately getting back on its track to be named as Najafgarh drain.

The Najafgarh drain/river enters NCT from the south western side and traverses a length of 41 Km before falling into river Yamuna in the northern part of Delhi.

The northern side is in Delhi and it is a place where most of the recreational activities are proposed the boundary is in Delhi where all the farmlands and villages are, West side is the area where the river opens up, the eastern side is where the lake ends, even the residential developments take place in this side and then water converges to Najafgarh drain, the southern is where all the biodiversity can be observed and is in Gurugram and then the farmlands starts

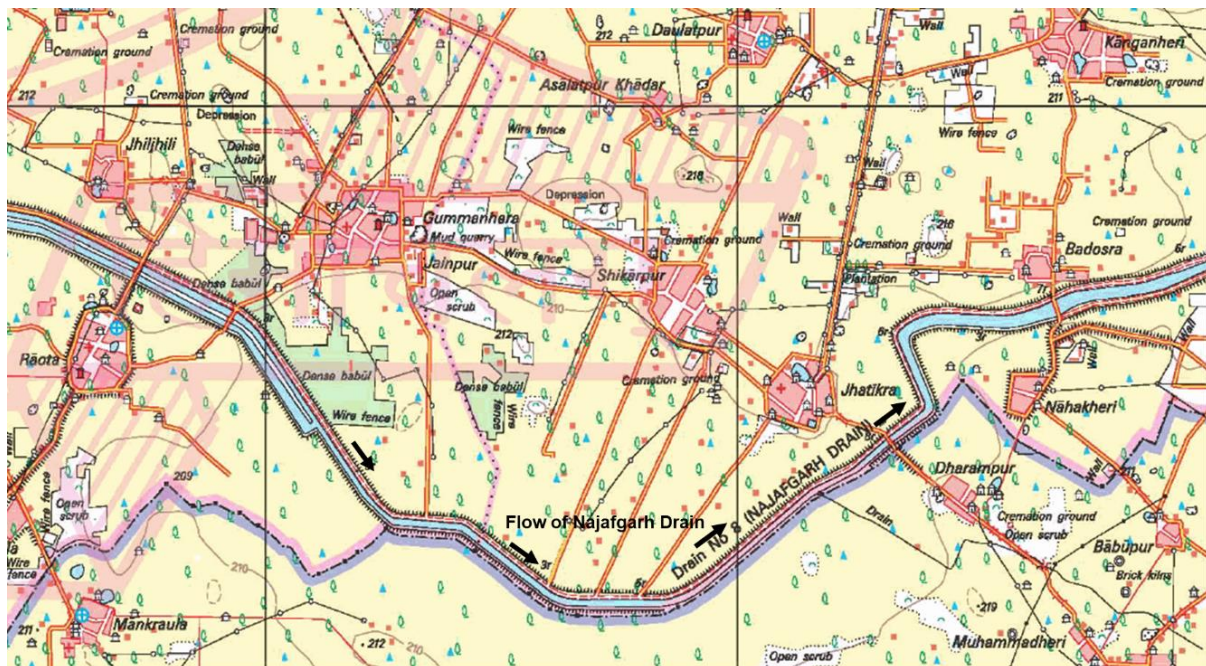


Figure 6: Survey of India Toposheet showing natural flow and location of Najafgarh Jheel

## 4.2 Climatic Factors

The climate of the area is majorly classified as tropical, semi-arid and hot with extreme dryness except monsoon months and cold winters. During monsoon, majorly from July to September, high humidity prevails in the area due to penetration of moist air which causes cloudiness and monsoon precipitation. The period from September to October is post monsoon season followed by cold weather which last from Late November to the beginning of March.

The meteorological data from Indian Meteorological Station, Palam has been used to assess the climatic behaviour of the area. IMD, Palam is the nearest station where climatic data is recorded. The meteorological data of Eleven years (2002-2013) as recorded are given below:

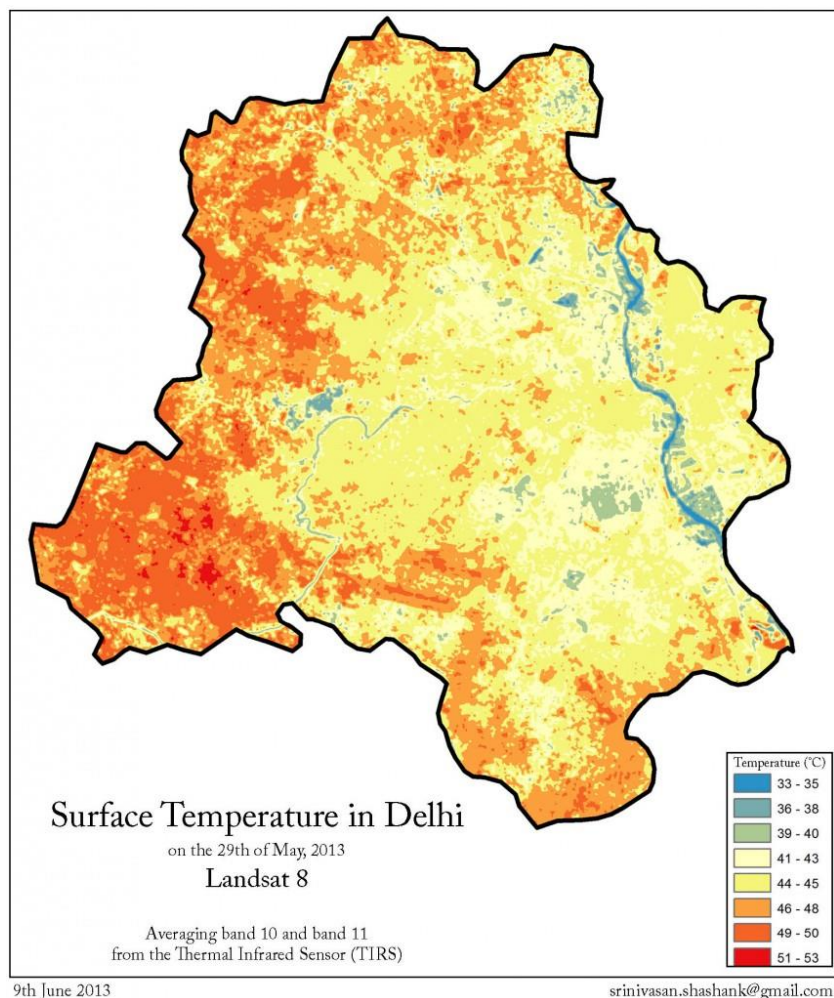


Figure 7: Surface temperature map of Delhi



#### 4.2.1 Rainfall Pattern and Distribution

The maximum rainfall was recorded in July (upto 495.6 mm) in 2003. From data, it is clear that maximum time of year are the dry months. July & August & September are the wettest months which are considered as monsoon season. The Average Annual Rainfall is 657.97 mm.

Table 1: Rainfall Record (mm) from year 2002-2013

Rainfall (mm)					
Month	Year	Max	Year	Min	Average
January	2003	39.2	2011	0.2	12.7
February	2013	75.5	2009	5.8	28.7
March	2007	53.0	2003	2.1	13.1
April	2003	28.3	2006	1.0	9.9
May	2002	150.7	2013	1.1	51.9
June	2013	154.4	2002	13.1	85.4
July	2003	495.6	2002	1.7	161.1
August	2004	218.6	2006	103.2	153.0
September	2011	320.6	2004	2.9	124.7
October	2004	76.7	2009	2.8	13.5
November	2009	3.4	2006	0.2	0.5
December	2003	18.7	2007	0.3	3.2

(Source: IMD Station, Palam)

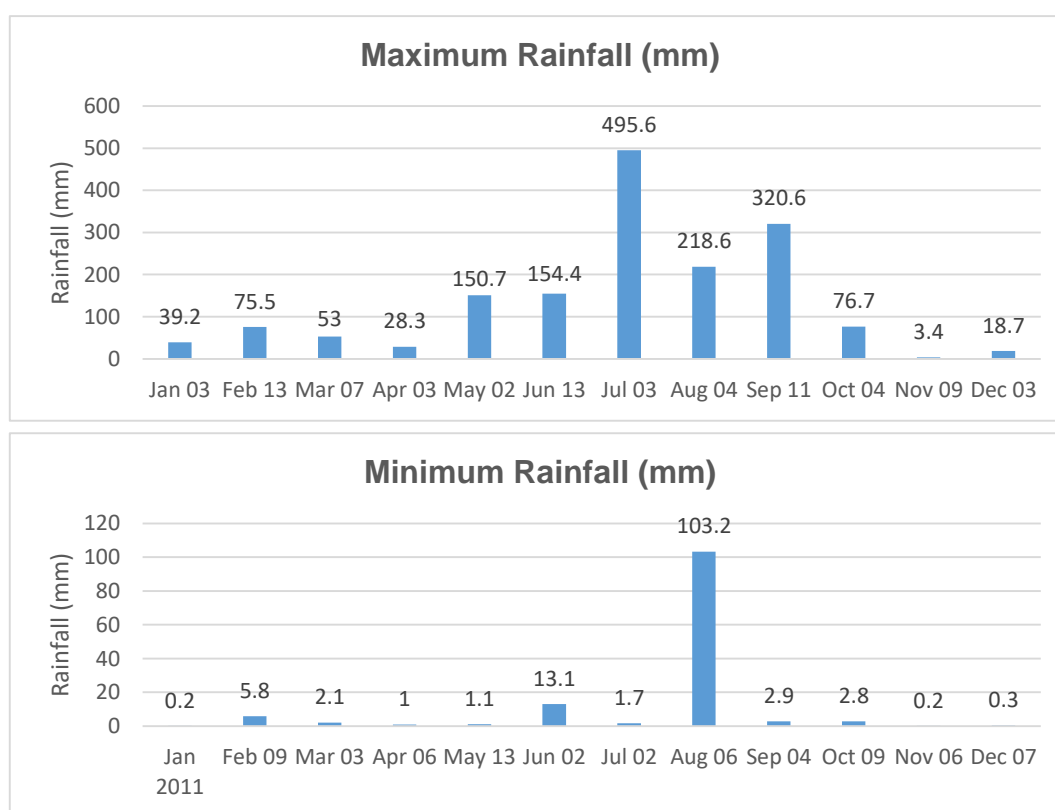


Figure 8: Figure showing maximum and minimum rainfall pattern (mm)



## 4.2.2 Temperature

The maximum temperature was recorded as 47.2 in June (2013) whereas the minimum temperature was recorded 0.3 in January 2006. Data of the maximum and minimum temperature are given below.

Table 2: Temperature Record (°C) from year 2002-2013

Temperature (°C)								
Month	Year	H Max.	Year	L Min.	Year	MMax.	Year	MMin.
January	2007	31.0	2006	0.3	2006	21.8	2008	6.9
February	2006	35.7	2004	3.2	2006	29.6	2002	9.6
March	2004	40.1	2003	6.7	2004	33.7	2003	15.1
April	2003	44.1	2013	12.0	2002	39.5	2005	20.6
May	2013	47.2	2004	16.8	2013	42.8	2008	25
June	2003	47.1	2011	21.4	2009	42.6	2008	26.2
July	2009	43.3	2003	23.0	2002	40.5	2003	26.3
August	2002	40.2	2013	20.8	2009	36.1	2004	26.2
September	2005	38.8	2002	20.4	2004	35.5	2002	23.5
October	2009	38.8	2004	13.7	2008	34.1	2007	17.7
November	2003	34.6	2003	5.9	2011	29.6	2003	11.8
December	2011	30.4	2013	3.1	2002	24.7	2005	5.9

(Source: IMD Station, Palam)

(H max- Highest max, L min- Lowest min, Mmax- Mean max., M min- Mean min.)

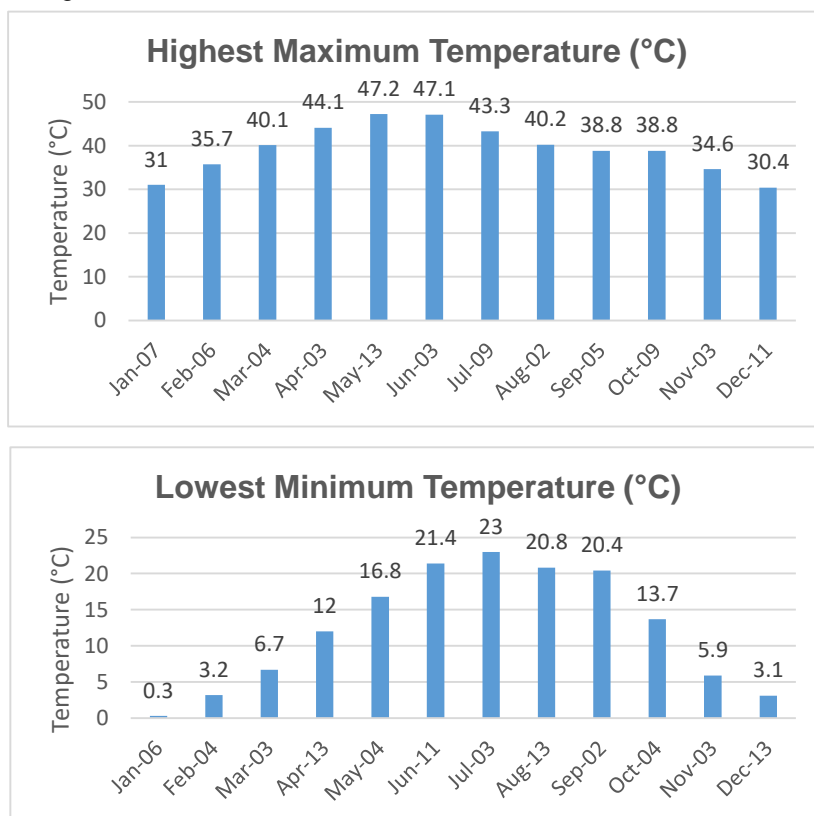


Figure 9: Figure showing maximum and minimum temperature (mm)



### 4.2.3 Relative Humidity

The Maximum relative humidity was recorded as 84.5% in January 2003. Minimum relative humidity was recorded as 25.5 % in April & May 2005. The humidity figures show that area is semi-arid.

Table 3: Humidity Record (%) from year 2002-2013

Humidity (%)				
Month	Year	Max	Year	Min
January	2003	84.5	2008	60.5
February	2013	79.5	2008	53.0
March	2013	63.0	2004	44.0
April	2013	46.0	2005	25.5
May	2006	45.0	2005	25.5
June	2008	70.0	2009	32.5
July	2013	78.0	2002	47.0
August	2013	83.0	2005	61.0
September	2003	74.5	2008	64.5
October	2013	69.0	2007	45.5
November	2011	63.0	2005	56.5
December	2003	78.0	2005	63.5

(Source: IMD Station, Palam)

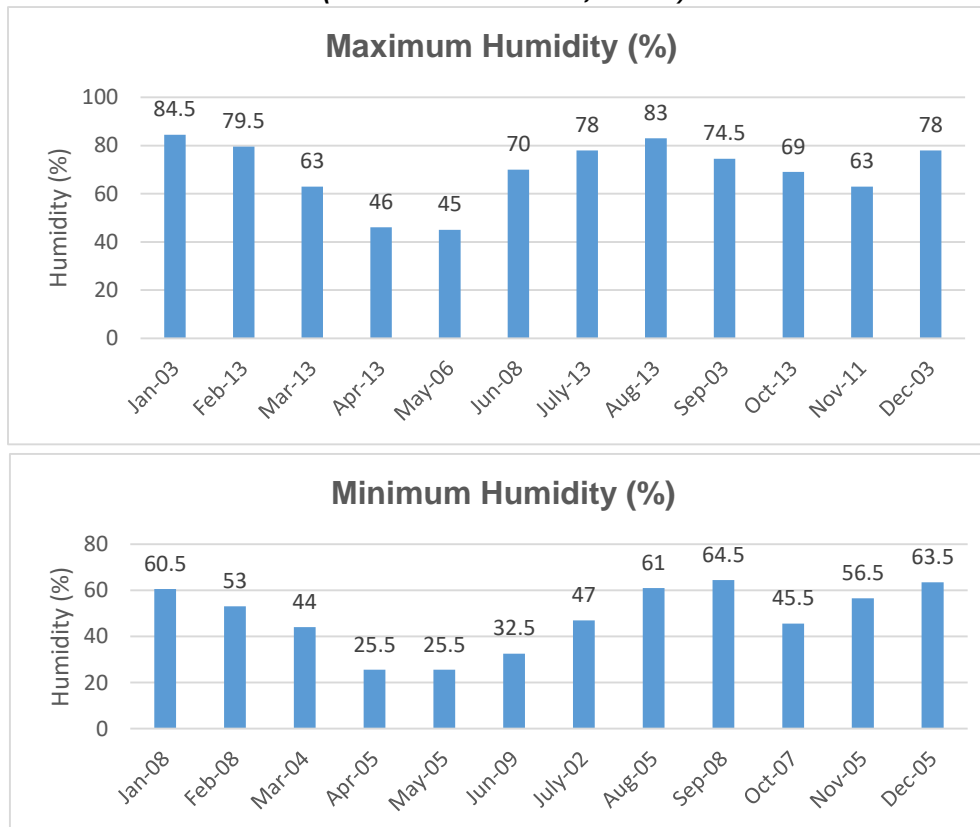


Figure 10: Figure showing maximum and minimum Humidity (%)



#### 4.2.4 Wind Speed and Direction

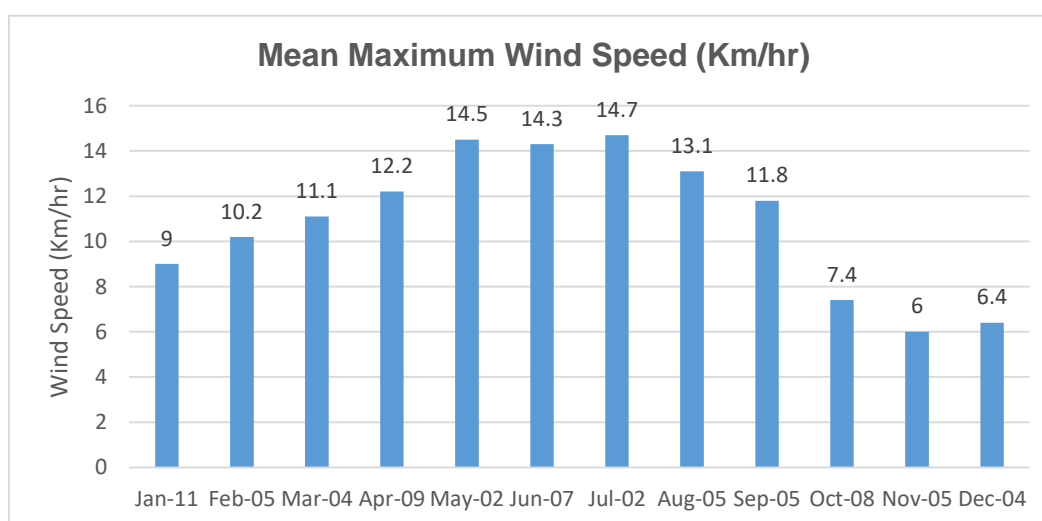
The winds are generally light to moderate in this area. It can be seen that the annual mean wind speed is 5.4km/h. The strongest winds are observed during May – June i.e. Summer Season and the weakest i.e. November- December.

The maximum wind speed was recorded in July (14.7 Km/hr.) in 2002 and minimum wind speed was recorded in December (2.4 Km/hr.) in 2004.

Table 4: Wind Speed (Km/hr) from year 2002-2013

Month	Year	Max Wind speed (Km/hr)	Year	Min Wind speed (Km/hr)
January	2011	9.0	2003	4.2
February	2005	10.2	2006	6.8
March	2004	11.1	2006	8.4
April	2009	12.2	2006	9.5
May	2002	14.5	2011	10.9
June	2007	14.3	2008	7.6
July	2002	14.7	2013	8.0
August	2005	13.1	2003	6.0
September	2005	11.8	2003	5.9
October	2008	7.4	2004	4.9
November	2005	6.0	2002	2.3
December	2004	6.4	2002	2.4

(Source: IMD Station, Palam)



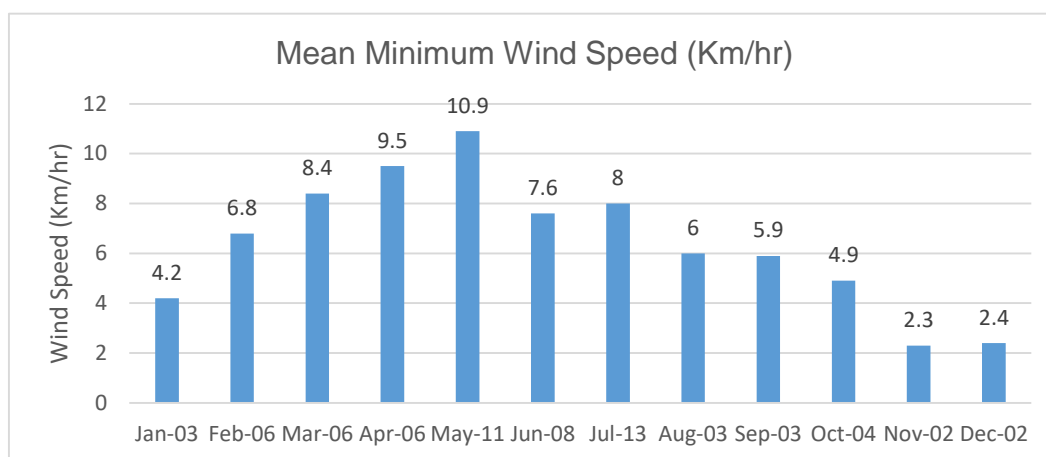


Figure 11: Figure showing maximum and minimum Wind Speed (Km/hr)

#### Wind Direction:

Month	Direction	Calm
January	NW	24.6%
February	W	18.2%
March	W	9.0%
April	NW	6.3%
May	W	5.0%
June	W	7.2%
July	E	7.4%
August	E	12.6%
September	NW	14.7%
October	NW	28.5%
November	W	46.3%
December	W	39.7%

Table 5: Wind Directin from year 2002-2013

#### 4.2.5 Cloudiness

Skies are heavily clouded during the monsoon season i.e. July and August and then sky is majorly clear or lightly clouded for rest of the year. But due to the western disturbances in the months of January, February and early March, skies become cloudy again.

#### 4.2.6 Water Sources

The NBS and the area surrounding the NBS are rich in water sources, the ground water table in this zone is at the highest and the farmlands enjoy plenty of their shares, majority of the water used in agriculture is from the tube wells but there have been reports of people using the lake water directly for the crops.



### **4.3 Geology, Rock and Soil**

The area under NBS and the surrounding areas comes under older alluvial plain, the soil is hydrophilic in nature which indicates a good ground water level and also this water body and its surrounding areas comes under good groundwater potential areas with water level less than 10m during monsoons.

Sahibi River which is a tributary of River Yamuna, forms the alluvial plain and thus, the soils are majorly classifies as tropical brown soils. The rock formation is found very deep as it gradually increases near the Delhi ridge area.



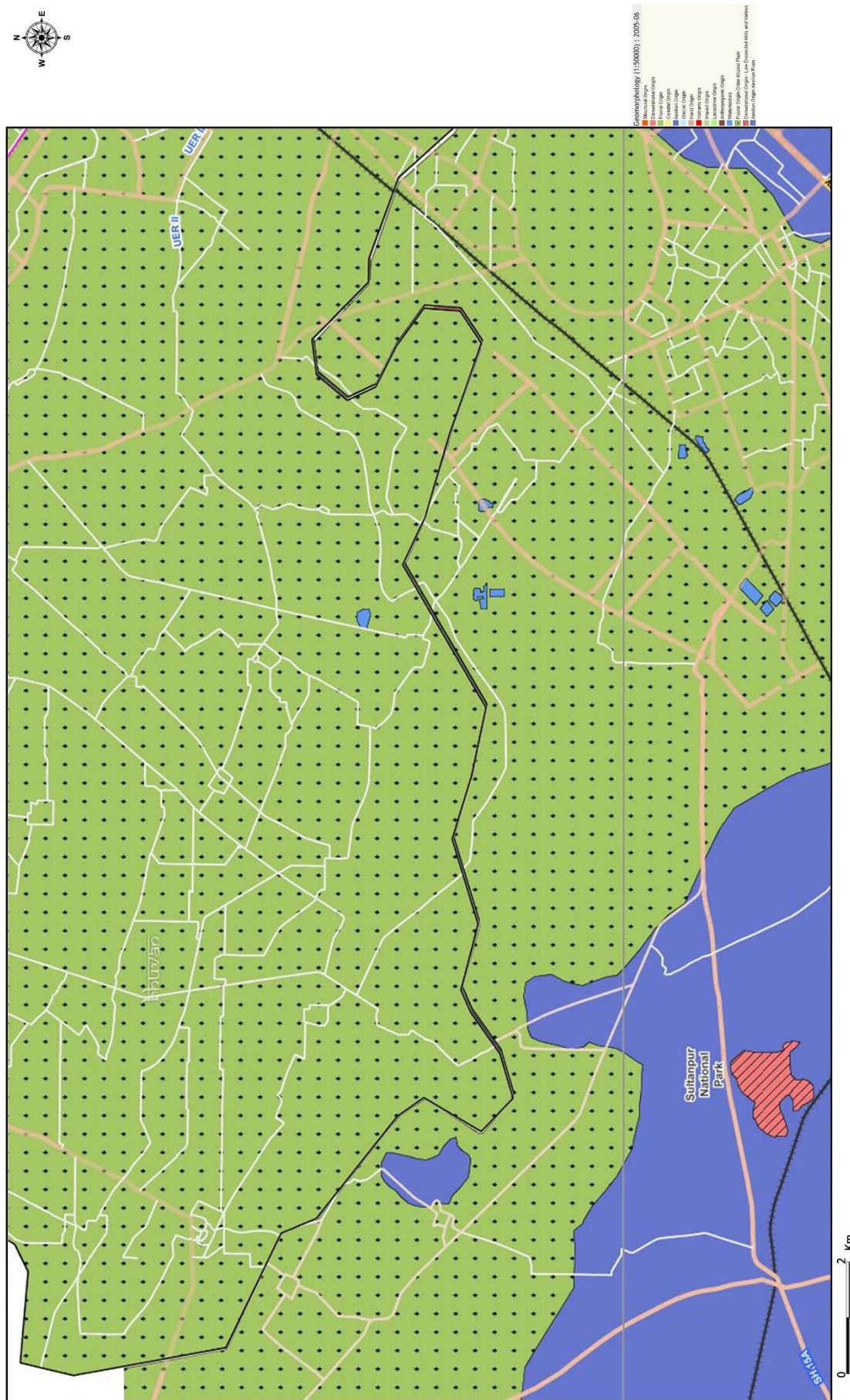


Figure 12: Bhuvan map showing the geomorphology of the area.

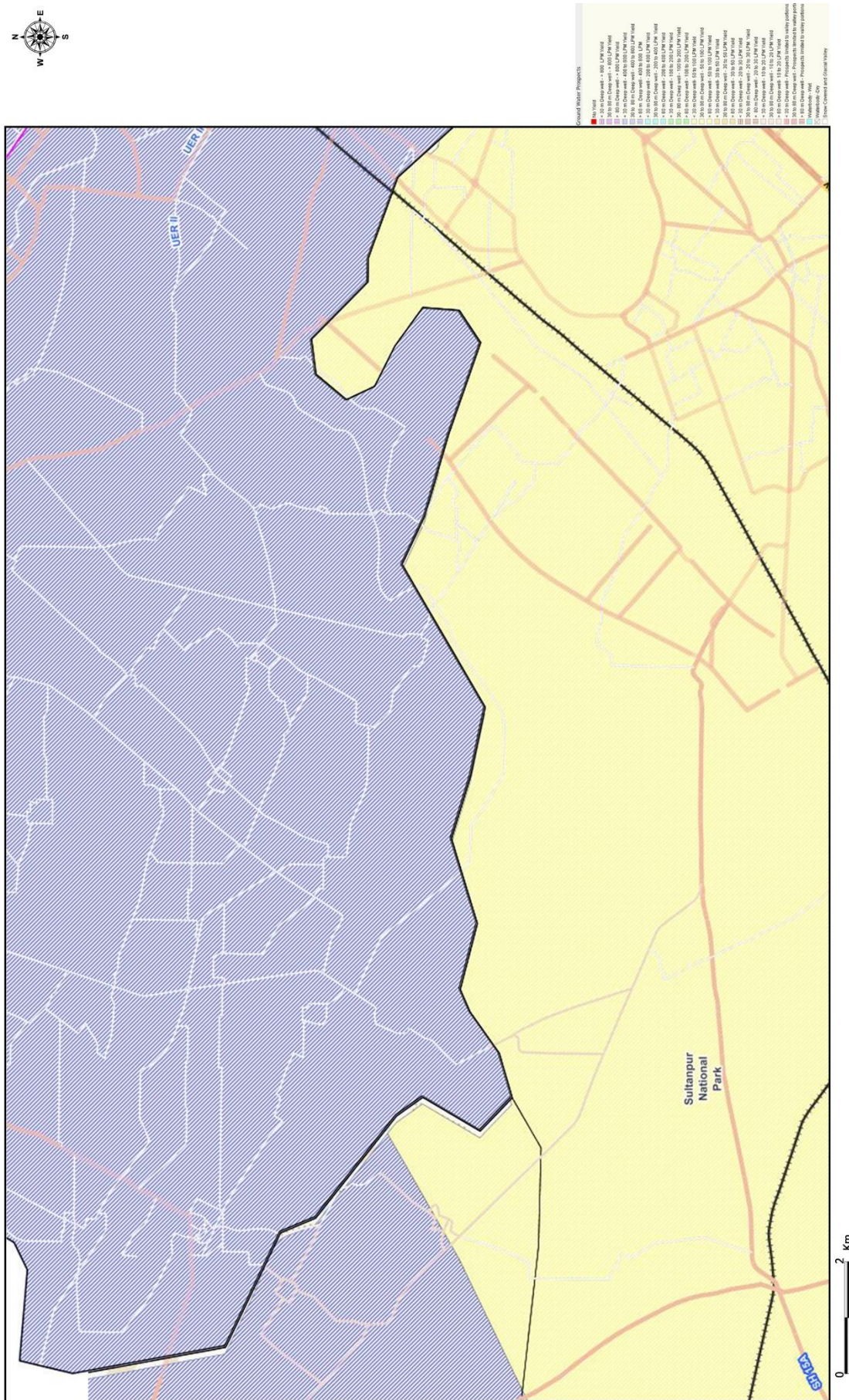


Figure 13: Bhuvan map showing the Ground Water Prospect of the area.



## **4.4 Terrain and Topography**

The terrain is almost flat and the area is the low point in the area and gets filled with water and stays under water throughout the winters.

Najafgarh basin has a natural depression called the Najafgarh jheel of about 10 sq.km area, to the South of the basin having an independent catchment of 219 sq. Miles. The Jheel used to be earlier submerged under water throughout the year and evaporation and percolation were the only means for its disposal, until the construction of the Najafgarh drain in the 19<sup>th</sup> Century.



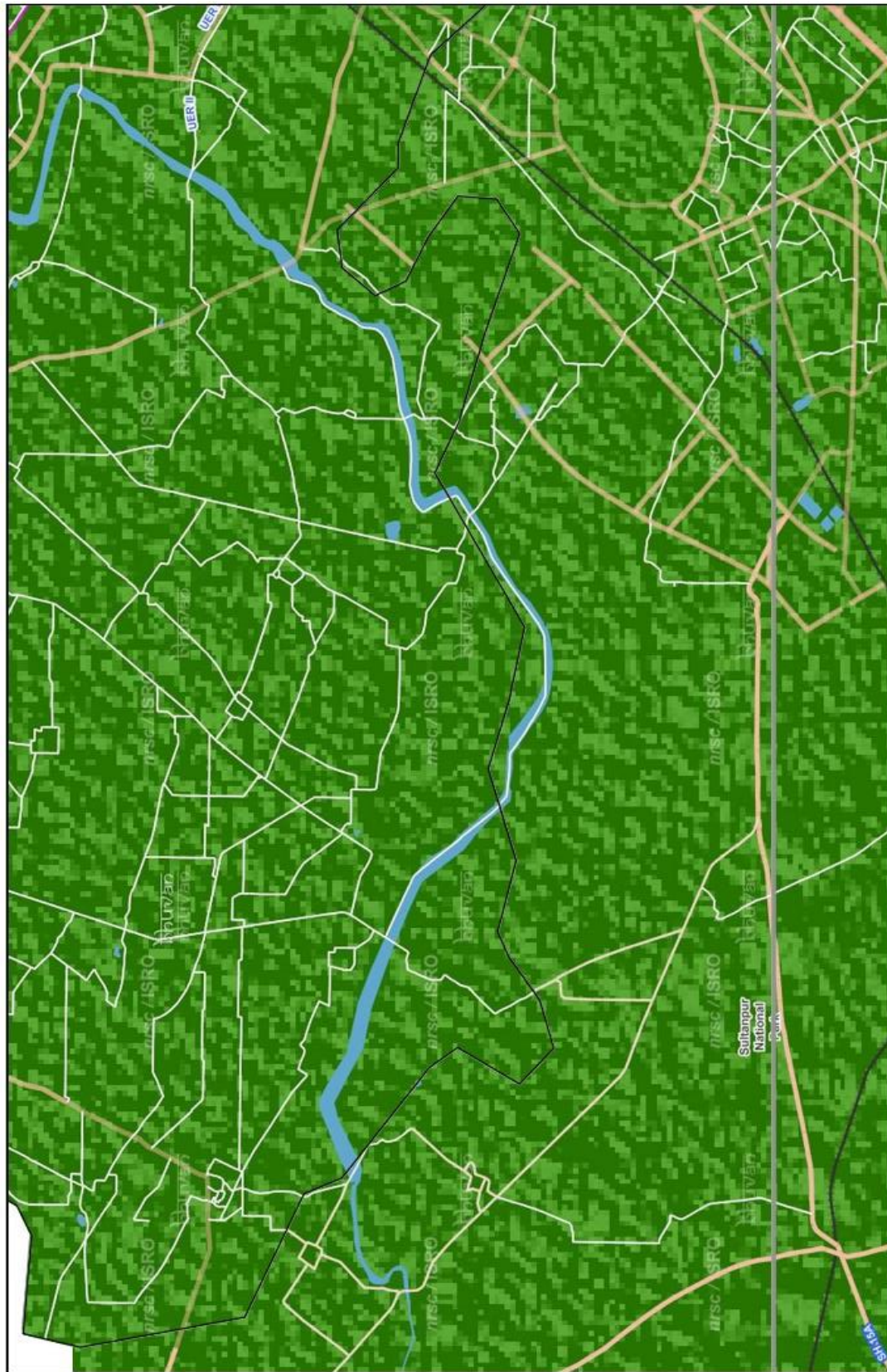


Figure 14: Bhuvan map showing the Terrain of the area.

### 4.5 Landuse Pattern

The master plan of Delhi 2021 shows the area in agricultural and green belt and in Gurugram it shows as special zone.

The zonal map of the L-zone where the site is located in Delhi, demarcates the lake and in contrast even shows parts of farmlands in Delhi under this water body.

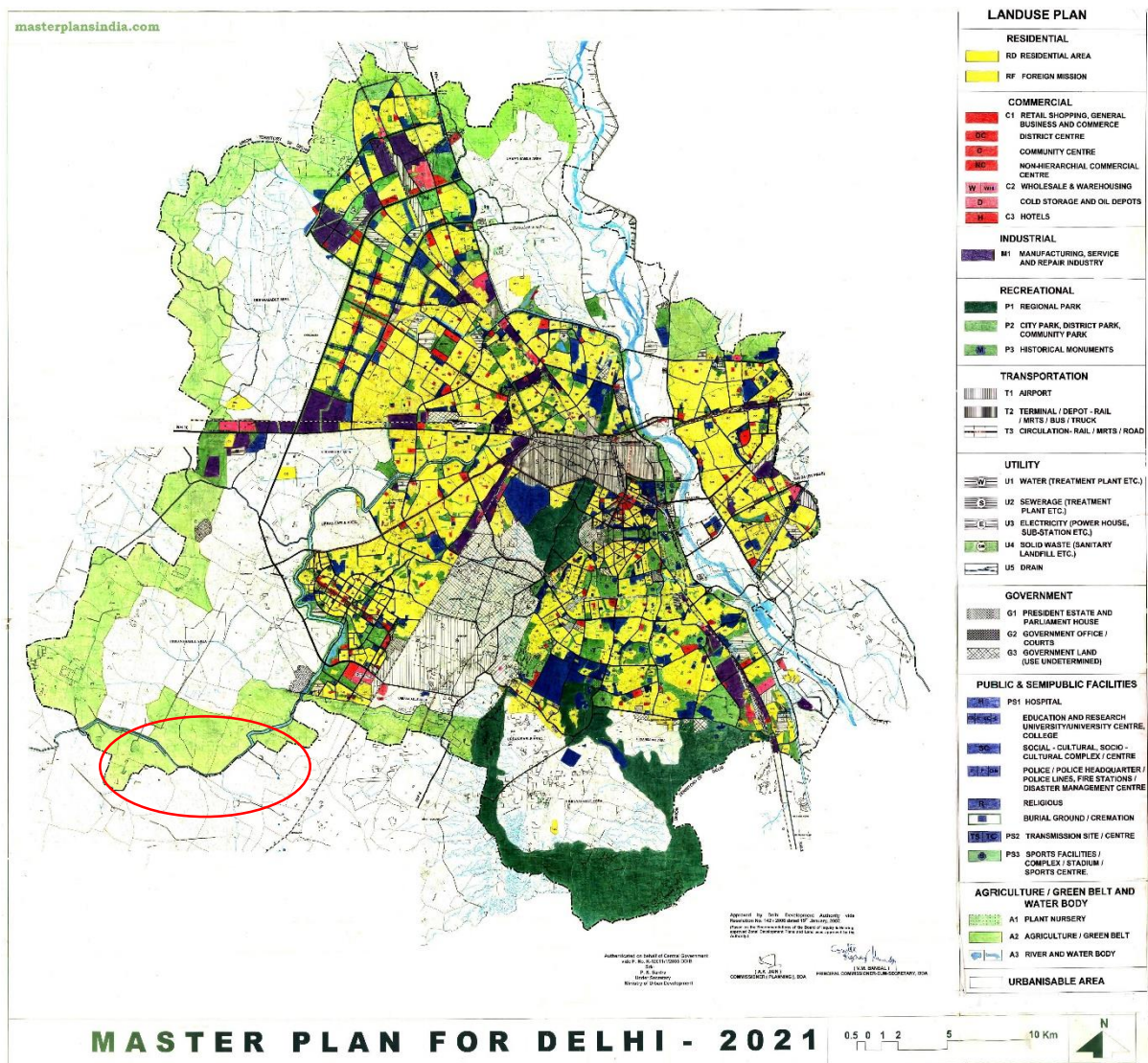


Figure 15: DDA's Delhi master plan with defined Landuse of the site



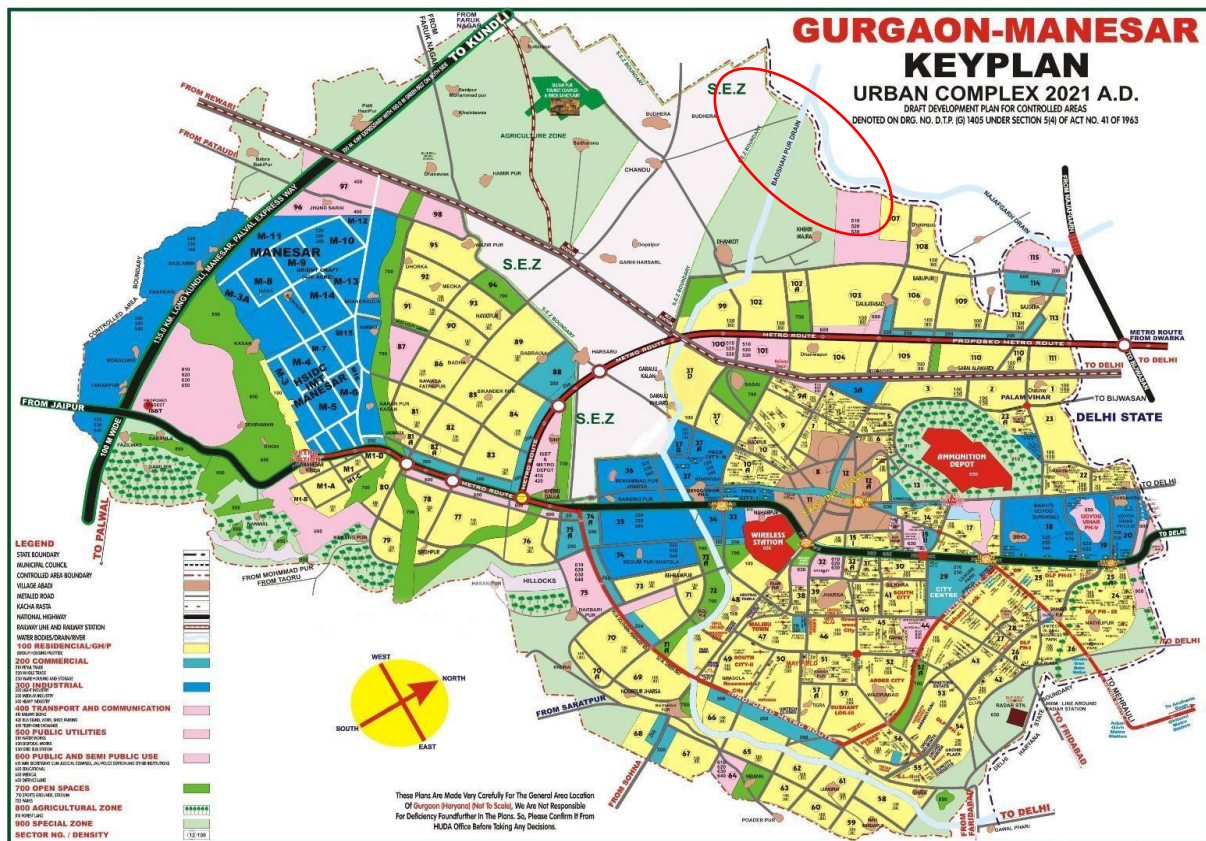


Figure 16: GDA’s Gurgaon-Manesar master plan with defined Landuse of the site

## The Waking Call

Najafgarh jheel (lake) was almost on the verge of being wiped off the map as Haryana and Delhi had gone into denial mode about its existence.

The INTACH had earlier raised an alarm over large-scale construction work done in the floodplain of the lake. On October 7, 2016, the Ganga Notification issued by the Ministry of Environment Forest and Climate Change (MoEF&CC) clearly stated that no construction should take place on the bank of Ganga or its tributaries or active flood plain area. As Najafgarh lake is an offshoot of Yamuna, which, in turn, is a tributary of the Ganga, it naturally falls in that category.



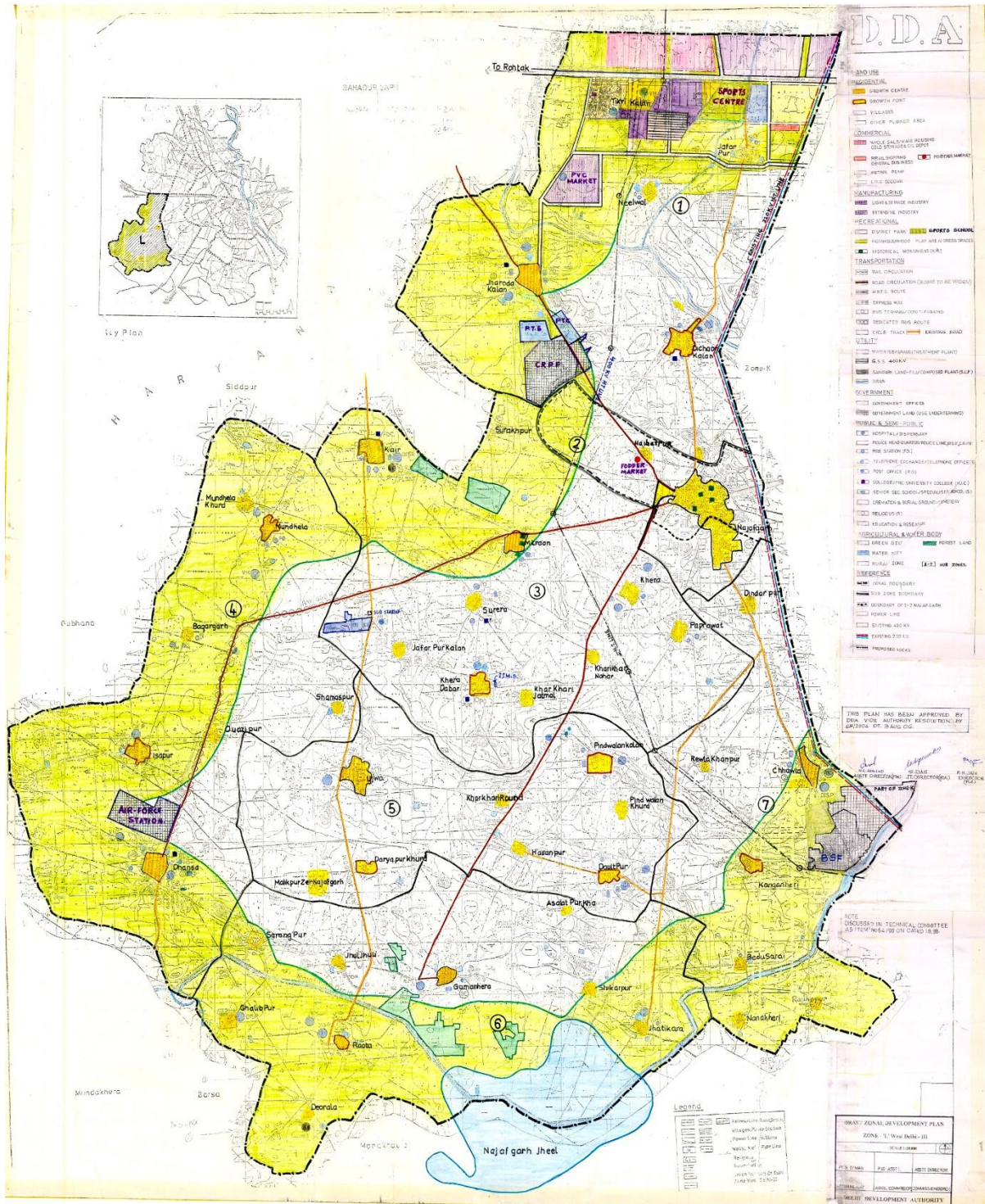


Figure 17: DDA's L-Zone master plan demarcating the extent of the Najafgarh Jheel.



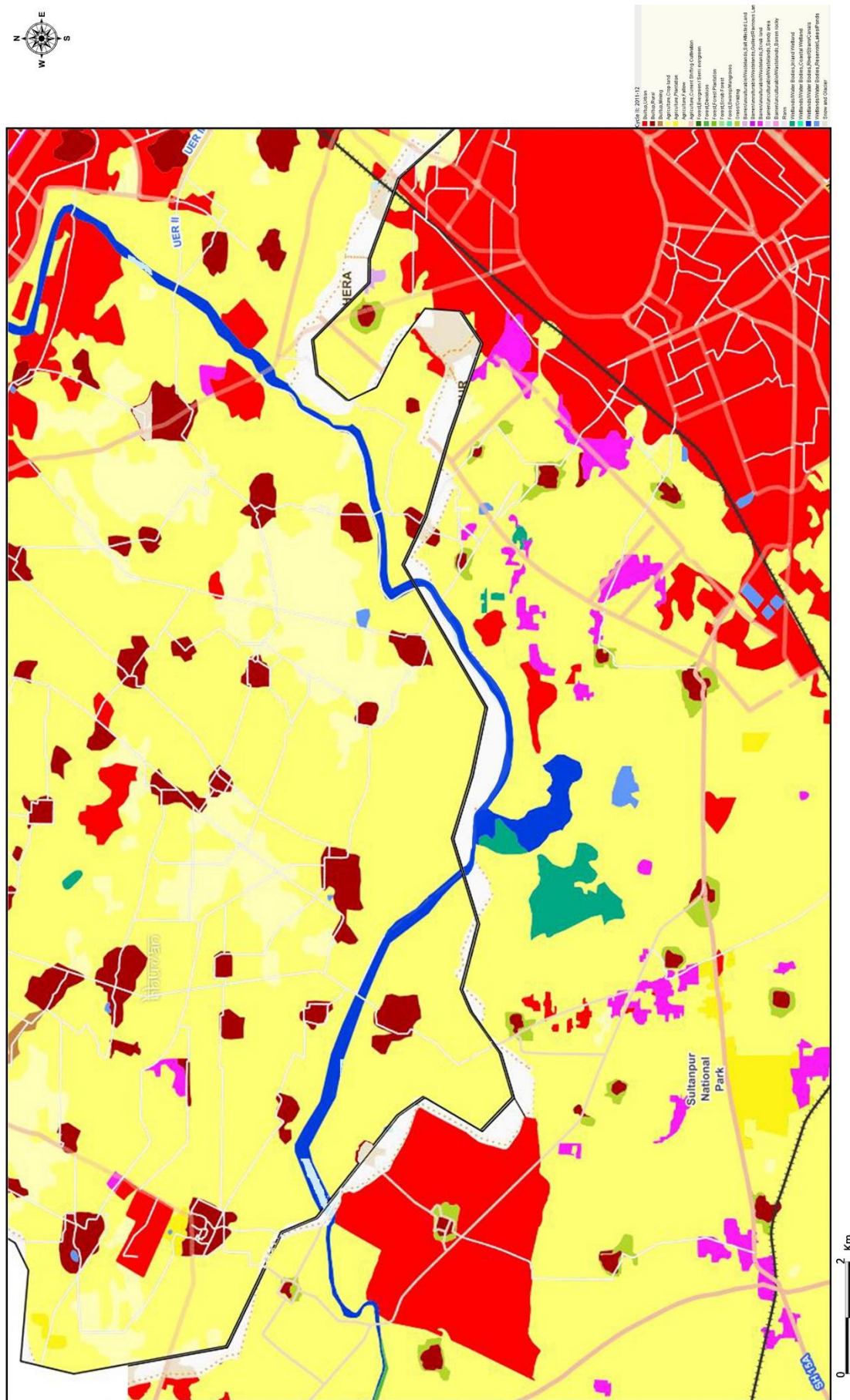


Figure 18: Bhuvan map showing the LULC Map of the area.

## 4.6 Hydrology

In a meeting [5th February, 2002 – Office of the Commissioner, MCD] of the several concerned govt. agencies it was noted that in the context of Delhi, water bodies are to be defined as “**Bodies of still waters in the Urbanscape or Ruralscape which are either naturally present or intentionally created**”.

**Najafgarh jheel** is an integrated part of the ganga river basin, it is a shallow water body along the course of river sahibi.



Figure 19: Graphical Representation of Sahibi River from watershed to basin

The major source of water in arid and semi-arid zones of Rajasthan and Haryana is Sahibi River. Since, the time of Indus valley civilization the river has been boasting the settlements along its banks. The Sahibi River is a short-seasonal stream because of irregular water supply. However, during monsoon, the stream's discharge can swell and overflow the banks causing large areas of land to be flooded.

The general direction of the flow of the stream is north which terminates in Delhi, where it is a tributary of river Yamuna.

Approximate length of the river is 300 kilometers and it drains a catchment area of 4442 square kilometers. Before it is converted into a drain in Delhi the river passes through the districts of Jaipur, Alwar, Rohtak, Mohindernagar and Gurgaon.

Every river originating in Aravalli follows the pattern of drainage flow towards south except the river Sahibi which flows in the direction towards north. Other tributaries of the river are Krishnawati River, Indori Nadi, etc

## The Yamuna Upper sub basin

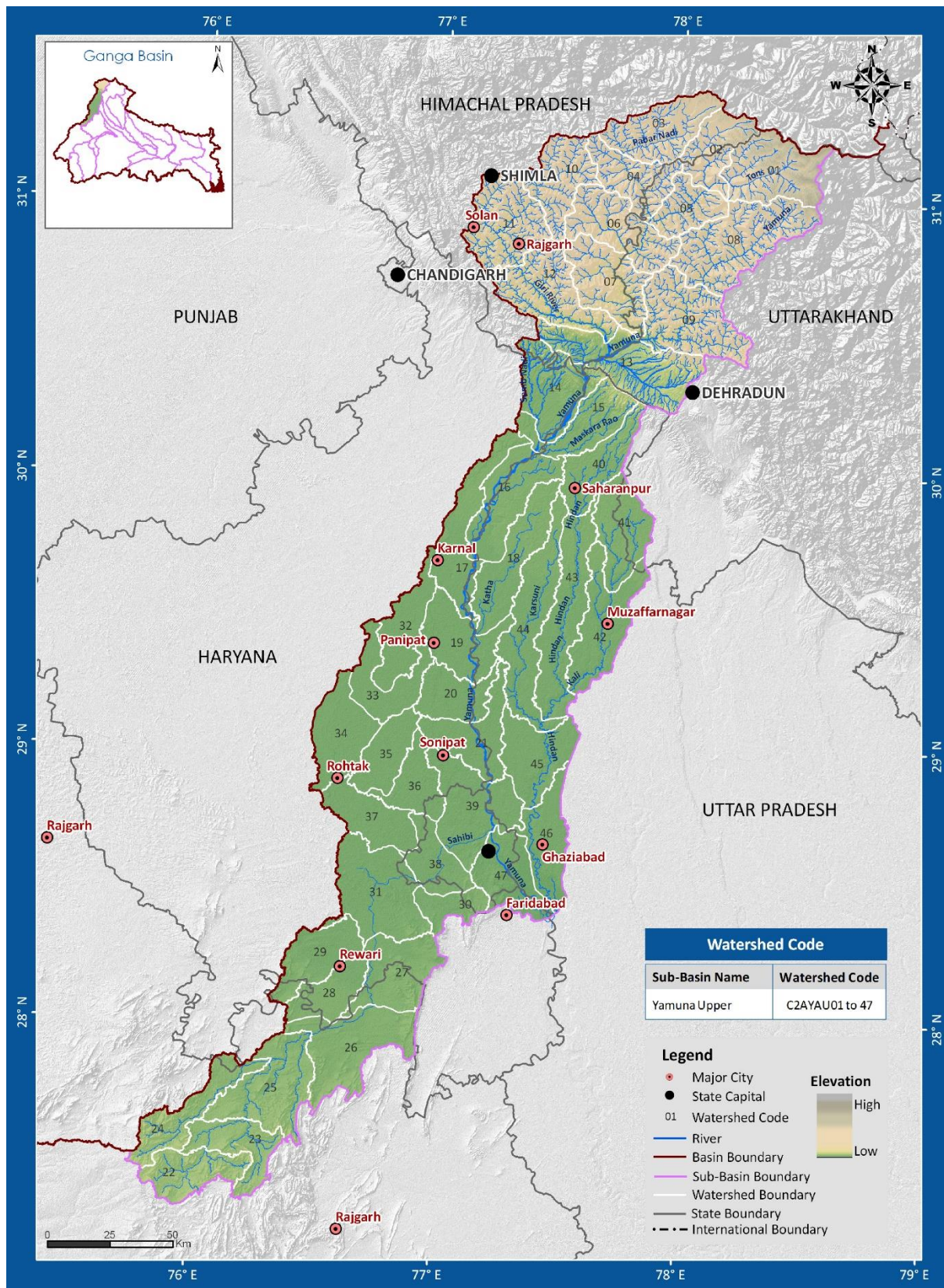


Figure 20: India WRIS image of Yamuna upper sub basin.



**The Najafgarh Drain :** After the sahibi river enters delhi the water quality is good until it reaches the jheel area where the large drain from Gurugram open here, and then while exiting the shallow water body the water quality deteriorates. But it is this Gurugram drain that help the jheel's ecosystem survive during karung summers as the sahibi river is seasonal river thus dries up in summers, and majority of the water going downstream the jheel is 100% untreated sewage water from Gurugram and Manesar.

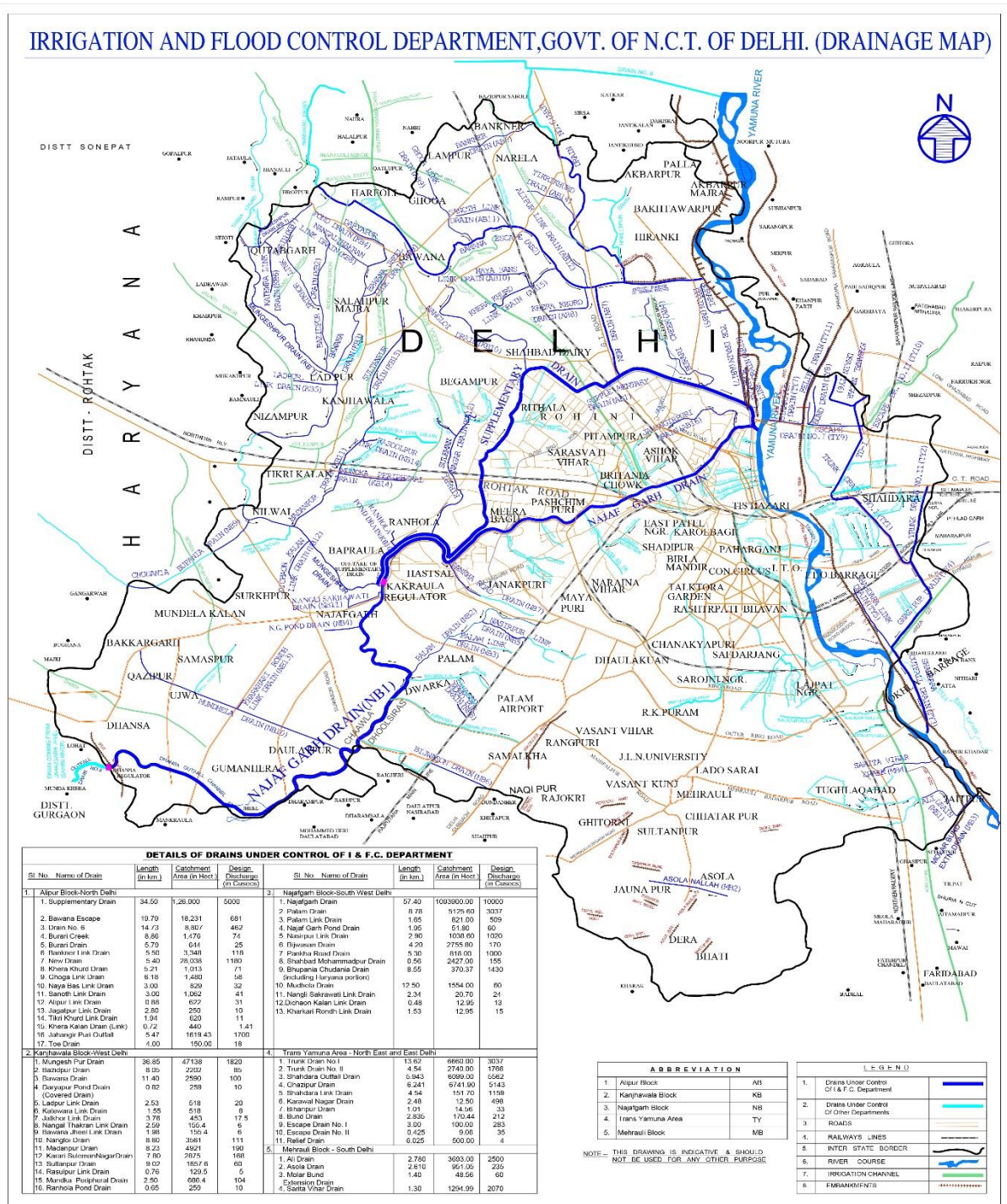


Figure 21: Drainage map of Delhi by IFCD, Govt. of Delhi, showing the Najafgarh drain.



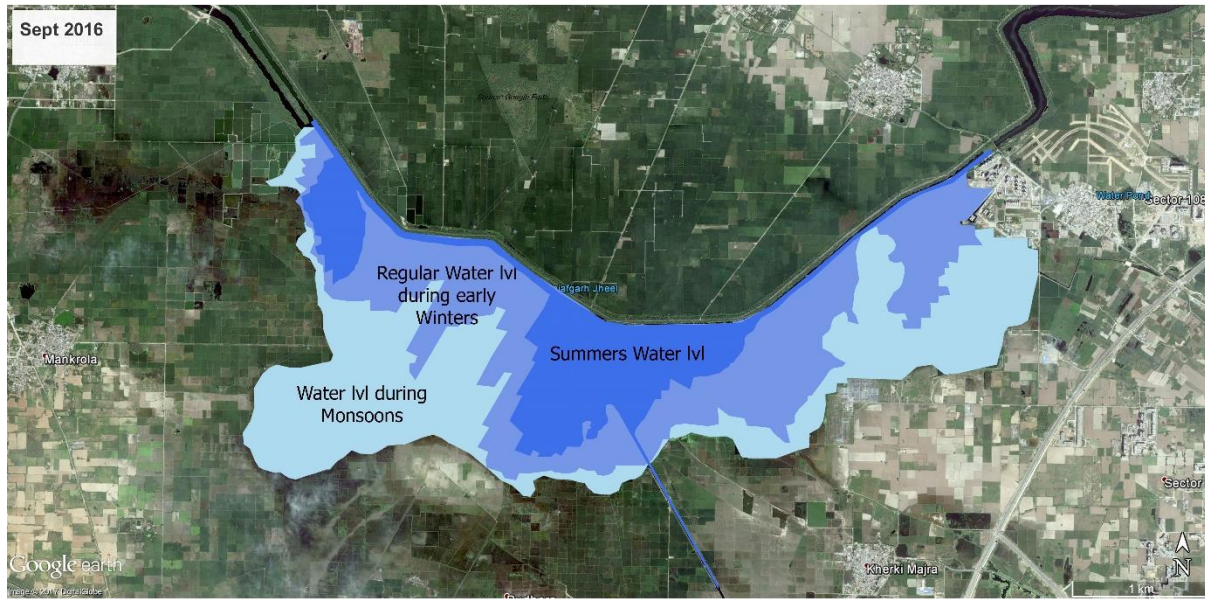


Figure 22: The seasonal variations in the water spread of the wetland.

## 4.7 Drainage Pattern and River Stream network

The major stream in the region is the Sahibi River which is joined by number of streams running the dendritic pattern. Streams order map generated from GIS software help us identify the pattern and the flow direction of the streams as well as the order of the streams.

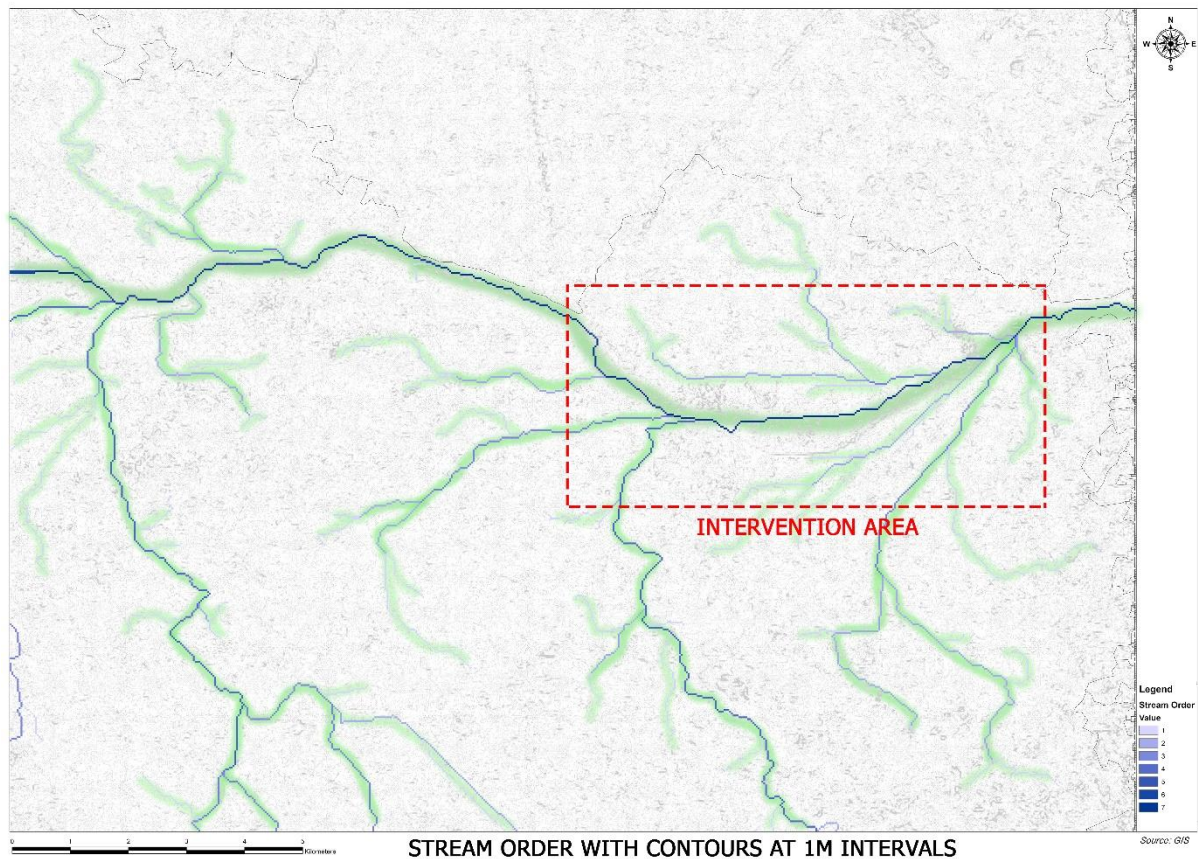


Figure 23: Stream order map with green patch depicting the Stream Corridor.

The drainage of the site is mostly the water runoff from the farms nearby and the storm water that river Sahibi brings. The two drains that meet the Sahibi River in the area from Gurugram side also adds to the drainage of the site but it polluted the water in the area to an extent that the actual drain starts forming after the mixing of these drains to the river.

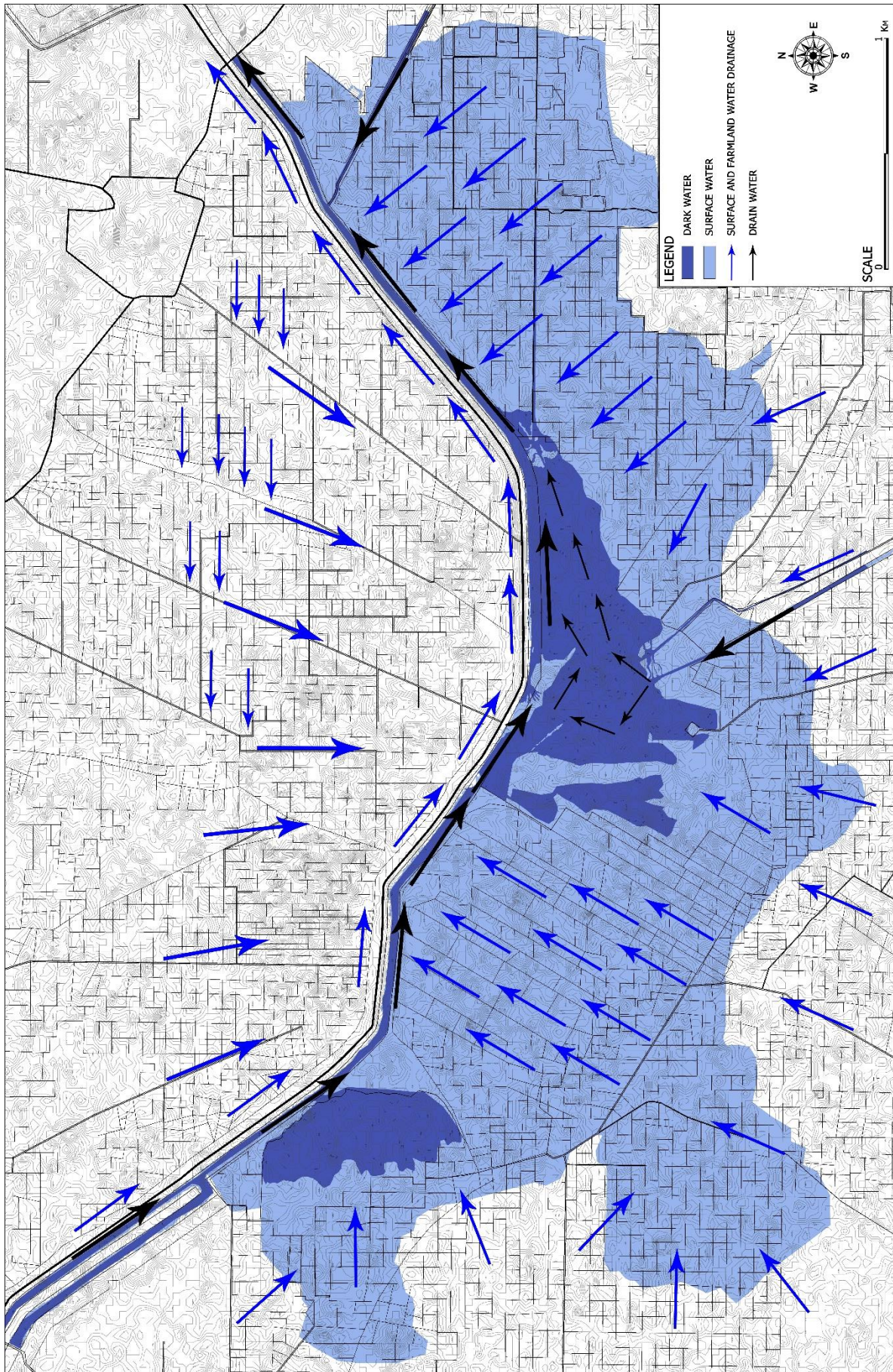


Figure 24: Surface drainage pattern of the area surrounding the Jheel.

## 4.8 Water Bodies in Delhi-NCR

In a meeting [5th February, 2002 – Office of the Commissioner, MCD] of the several concerned govt. agencies it was noted that in the context of Delhi, water bodies are to be defined as **“Bodies of still waters in the Urbanscape or Ruralscape which are either naturally present or intentionally created”**.

**“Areas of unintentional water logging along railway tracks, highways are excluded”**.

### 4.8.1 Types of water bodies in Delhi

Historically and culturally water bodies have always been associated with the living styles of royalty as well as commoners.

#### **Village pond/Johar:**

The village ponds are mostly created water bodies which have a very small localized catchments for gathering rainwater. Some of the ponds have become absorbed in the urban area or encroached by growing village settlements where they have been used to discharge the local waste waters and thus become cess pools.

#### **Lakes:**

Most prominent are Bhalaswa Lake (a fresh water oxbow lake on the river floodplain), Sanjay Lake [apparently a meander scour on the floodplain] in East Delhi, Najafgarh Jheel which used to be the largest lake in this area now lies mainly on the Haryana side of the inter-state border, HauzShamshi, HauzKhas, Old fort Lake.

#### **Marshes:**

At present, the largest water body in Delhi is Jahangirpuri Marshes which is now outside the floodplain embankments

#### **Stepwell and Baolis:**

These are different categories of water bodies. They are created for drinking water purposes and get water out ground water.



Water bodies under the jurisdiction of various departments/authorities/bodies responsible for its maintenance, development and improvement etc till 2010:

Sl. No.	Department/Authority/Autonomous Body	Approximate Number of Water Bodies in their jurisdiction
01	Revenue Deptt/Irrigation & Flood Control Deptt.	476
02	Delhi Development Authority	118
03	Department of Archaeological Survey	15
04	Department of Forest	12
05	Central Public Works Department	04
06	Public Works Department	02
07	Municipal Corporation of Delhi	01
08	I.I.T	01
	<b>TOTAL</b>	<b>629</b>

Table 6: Wind Speed from year 2002-2013

#### 4.8.2 Issues in Preservation

Institutional arrangements in preserving the water bodies is very weak. Preservation of water bodies cannot be done by single government agency. It requires help and support of different agencies which are not charged for their preservation or maintenance.

Despite of the conduction of various surveys, there are still some doubts regarding the precise number of water bodies. The areas that are submerged are still unmapped and unmeasured. This uncertainty hinders the development of an action plan and also deprives monitoring of changes.

Although it is not possible to rejuvenate all the water bodies thus, it arises a major issue that which water body to preserve or whether every single water body should be preserved as it is or should the present available water spread be maintained on a regular basis.



## 4.9 Site's present scenario

When talking about the present scenario of the site the more we go in depth the more we learn about the site's condition, the single approachable side through road is the northern side and the southern side is partially accessible by rammed earth road which till summers arrive is full of wet mud so is difficult to access.

The site visits were divide to three time periods so as to properly map the conditions of the seasonal inland wetland, the time periods decided were:

- Post monsoons – September 2017
- Mid winters – December 2017
- Post winters – February 2018

For better understanding of the condition the site was divided into grids each being 1sqkm to do a visual analysis per grid:

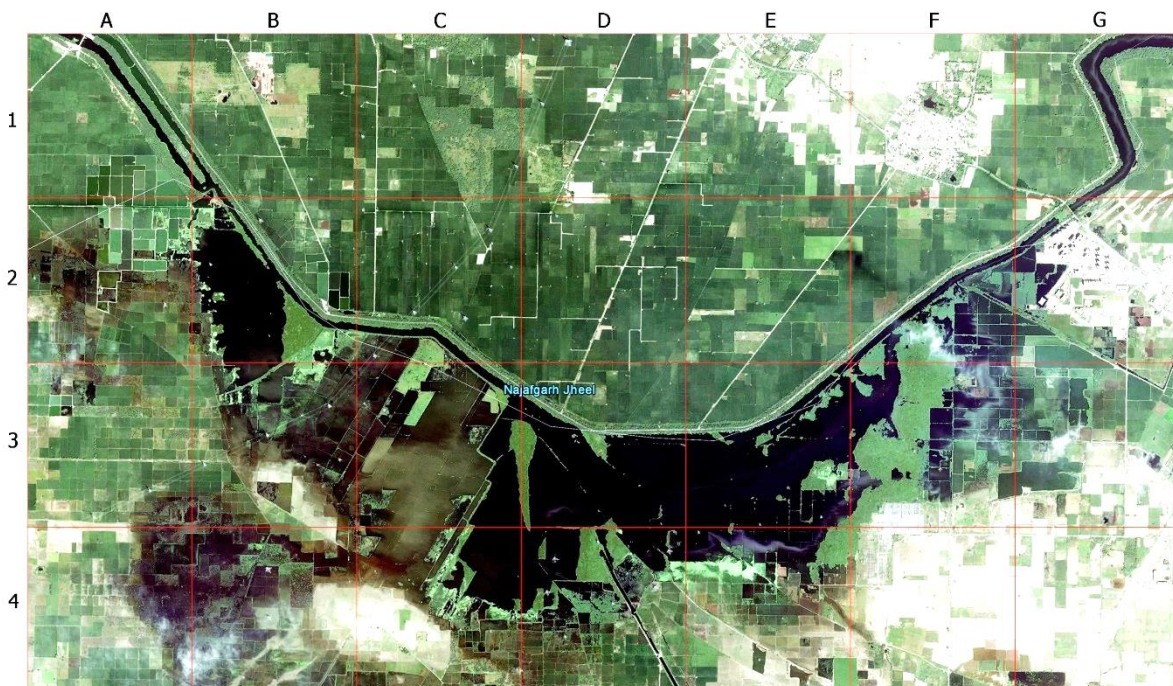


Figure 25: Google Earth image of the site with (1X1)sqkm grid

**G1:****Figure 26: Site images in grid G1****Observations:**

Dense vegetation on both sides of the road. The typology of vegetation changes in intervals. Visual penetration scarce in parts of the road. Canopy dense to nil. Not well developed road edge. A sense of enclosure which provides suitable habitat for birds. Mild vehicular movement.

**G2:****Figure 27: Site images in grid G2****Observations:**

Dense vegetation on one side and the other side is open. The characteristics of vegetation changes in intervals. Visual penetration very clear on one side. Canopy scarce. The crossing seems like a local trash can. The flood plains are visible and clear signs of bird habitat is visible. Mild vehicular movement.

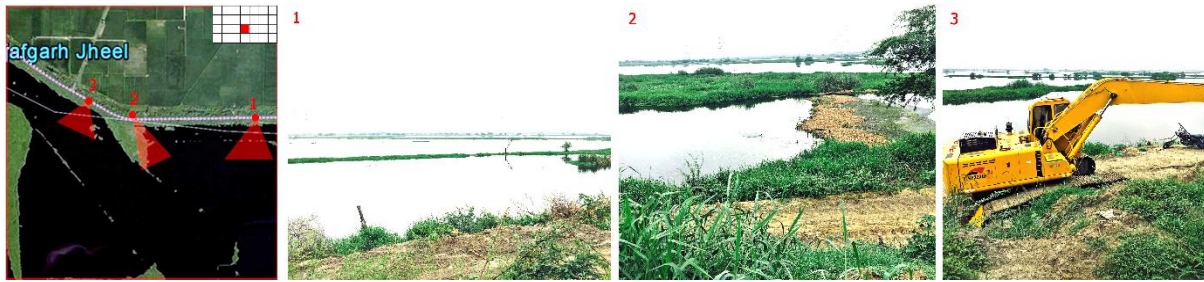


**F2:****Figure 28: Site images in grid F2****Observations:**

Dense vegetation on one side and the other side is open. The characteristics of vegetation changes in intervals. Visual penetration very clear on both sides, farmlands are visible. Canopy scarce. The openness of the site seems welcoming. The flood plains are visible and clear signs of bird habitat is visible. Mild vehicular movement.

**E3:****Figure 29: Site images in grid E3****OBSERVATIONS:**

Dense vegetation on both sides of the road. The typology of vegetation changes in intervals. Visual penetration scarce in parts of the road. Canopy dense to nil. Not well developed road edge. A sense of enclosure which provides suitable habitat for birds. Mild vehicular movement.

**D3:****Figure 30: Site images in grid D3****Observations:**

Dense vegetation on both one side of the road. The typology of vegetation changes in intervals. Far sight vision is achieved and the lake is dominant. Canopy dense to nil. Not well developed road edge. Desilting works are done before and after the monsoons. Mild vehicular movement.

**C2:****Figure 31: Site images in grid C2****Observations:**

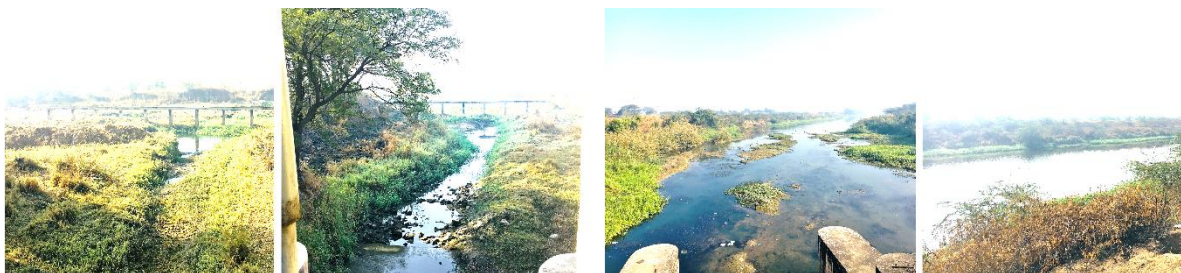
Dense vegetation on one side and the other side is open. The characteristics of vegetation changes in intervals. Visual penetration moderate on the sides. Canopy scarce. The electric tower works as a high visual area for the predator birds. The flood plains are visible and clear signs of bird habitat is visible.

**B1:****Figure 32: Site images in grid B1****Observations:**

Dense vegetation on one side and the other side is open. The characteristics of vegetation changes in intervals. Visual penetration moderate on both sides, farmlands are barely visible. Canopy scarce. The openness of the site seems welcoming. The flood plains are visible and clear signs of bird habitat is visible. Mild vehicular movement.

**A1:****Figure 33: Site images in grid A1****Observations:**

Dense vegetation on one side and the other side is open. The characteristics of vegetation changes in intervals. Visual penetration very clear on one side. Canopy scarce. The crossing seems like a local trash can. The flood plains are visible and clear signs of bird habitat is visible. Mild vehicular movement.

**Sahibi river condition near Dhansa barrage before entering Delhi:****Figure 34: Site images near the Sahibi river entering Delhi**

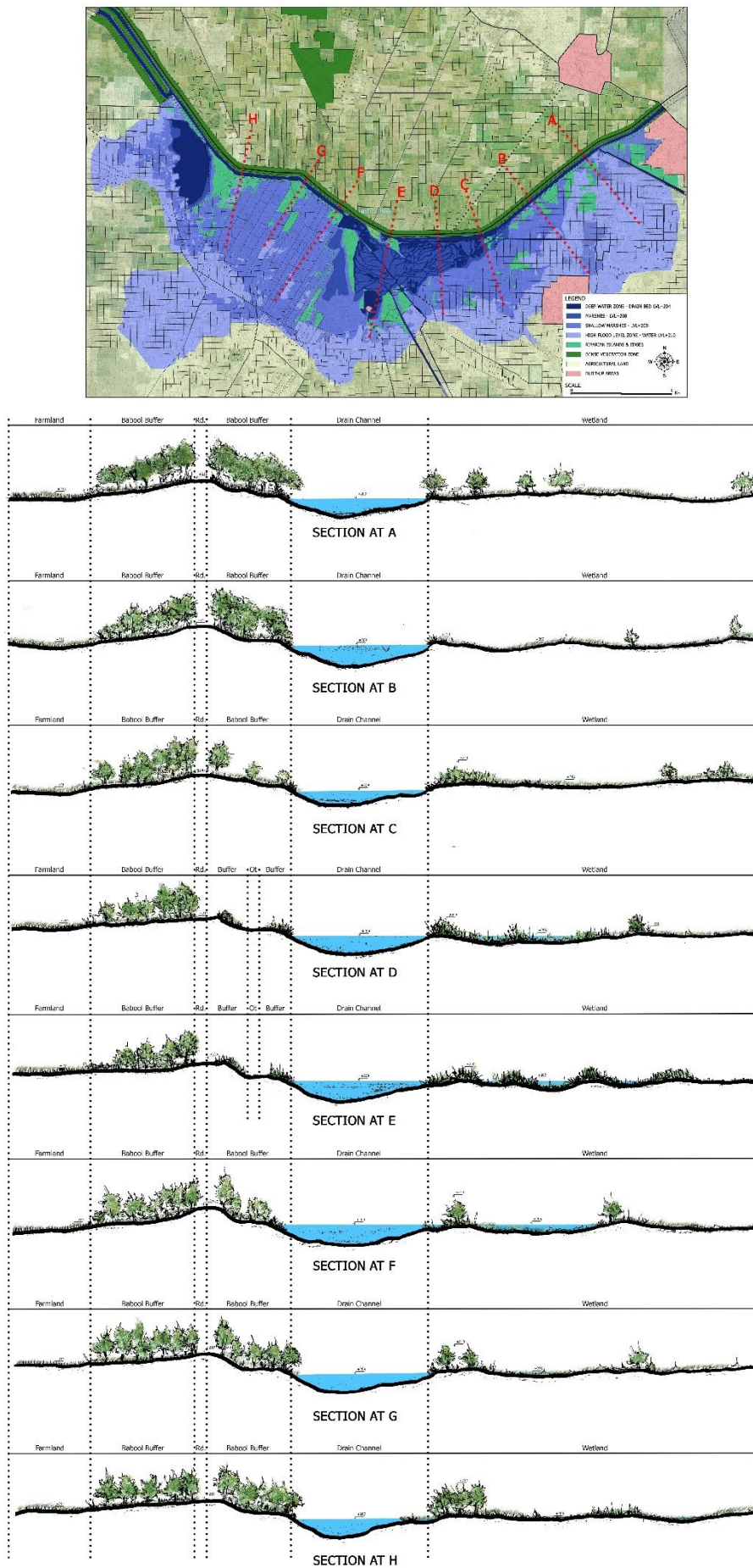


Figure 35: Existing site sections.



## 4.10 Activities In and Around NBS

When talking about the related activities that happen in the NBS and the ESZ, there is a need for the prohibition and regulation of such activities. However, which activity is to be regulated and prohibited is entirely dependent on the protected area. A broad list of activities which could be allowed, regulated, prohibited or promoted are listed below:

The purpose of prohibiting or regulating of any activity solely depends on its negative impacts on the wetland ecosystem, on the overall Landscape and on the Avifauna.

Table 7: Activities with their applications.

S.No	Category	Activities
1	<b>Prohibited activities</b>	a) Commercial mining, stone quarrying and crushing units.
		b) Setting up of saw mills.
		c) Use or production of any hazardous substances
		d) Setting up of industries causing water or soil or noise pollution.
		e) Establishment of new major thermal & hydro-electric projects.
		f) Commercial use of firewood.
		g) Use of plastic bags.
		h) Undertaking activities related to tourism like over-flying the national park area by aircraft, hot-air balloons.
		i) Discharge of untreated effluents and solid waste in natural water bodies or land area.
2	<b>Promoted activities</b>	a) Ongoing agriculture and horticulture practices by local communities along with dairies, dairy farming, aquaculture and fisheries.
		b) Organic farming.
		c) Adoption of green technology for all activities.
		d) Rain water harvesting
		e) Use of Renewable energy sources
		f) Cottage industries including village artisans



<b>3</b>	<b>Regulated activities</b>	a) Establishment of hotels and resorts.
		b) Construction activities
		c) Trenching ground
		d) Discharge of treated effluents and solid waste in natural water bodies or land area
		e) Air and Vehicular Pollution
		f) Noise Pollution
		g) Extraction of ground water
		h) Felling of trees
		i) Insulation of electric lines
		j) Widening and strengthening of existing roads.
		k) Fencing of existing premises of hotels and lodges.
		l) Drastic change of agriculture system
		m) Commercial use of natural water resource including ground water harvesting.
		n) Movement of vehicular traffic at night
		o) Introduction of exotic species.
p) Protection of hill slopes and river banks		



## 4.12 Quantifying the Impact

### Methodology of Assessment

The overall impact on air, water, noise, soil, flora & fauna, economy etc. is assessed based on a matrix. The assessment of the impacts is done after adopting proper mitigation measures. The criteria of the assessment are as follows:

4	Major
3	Moderate
2	Minor
1	Negligible
0	None
-1	Negligible
-2	Minor
-3	Moderate
-4	Major

Table 8: rating for the matrix

<b>Horizontal axis</b>	Envisaged Impacts
<b>Vertical Axis</b>	Environmental Factors

Table 9: Axis



MATRIX OF NAJAFGARH BIRD SANCTUARY (After Mitigation Measures are taken)										
Envisaged Impact Factors	Foundation	Use of Building Materials	Operation of construction equipment	Construction of Internal Roads	Generation of waste	Plantation	Rainwater Harvesting structures	Use of renewable energy	Total (Overall Impact)	
<b>Physical Components</b>	Air	-1	-1	-2	-1	0	4	0	3	
	Water	-1	-2	0	0	0	4	2	7	
	Noise	-1	0	-2	-1	0	4	1	1	
	Land	-1	-1	0	3	-1	4	0	8	
<b>Biological Components</b>	Erosion	-2	0	-1	-1	0	4	0	3	
	Diversity of Flora	0	0	0	0	0	4	0	7	
	Diversity of Fauna	0	0	-1	0	0	4	0	3	
	Ornithofauna	0	0	-1	0	0	4	0	3	
<b>Socio-cultural Components</b>	Landscape	0	0	0	0	0	4	0	6	
	Rare and unique species	0	0	0	0	0	4	0	4	
	Economy	0	4	0	0	0	4	3	15	
	Health & Safety	0	0	0	0	0	0	0	0	
Tourism	0	0	0	0	0	4	3	1	8	
		-6	0	-7	0	-1	48	23	11	68





<b>Impact Assessment Matrix</b>			
<b>ENVIRONMENTAL BASELINE MATRIX</b>			
<b>S. No.</b>	<b>Identification</b>	<b>Evaluation</b>	
	<b>Environmental Element/ Units</b>	<b>Impact</b>	
		<b>Score</b>	<b>(Negative/Positive)</b>
1	Emissions to Air	3	<b>Positive</b>
2	Releases to Water	7	<b>Positive</b>
3	Noise	1	<b>Positive</b>
4	Land	8	<b>Positive</b>
5	Erosion	3	<b>Positive</b>
6	Diversity of Flora	7	<b>Positive</b>
7	Diversity of Fauna	3	<b>Positive</b>
8	Ornithofauna	3	<b>Positive</b>
9	Landscape	6	<b>Positive</b>
10	Rare and Unique species	4	<b>Positive</b>
11	Economy	15	<b>Positive</b>
12	Health & Safety	0	<b>Positive</b>
13	Tourism	8	<b>Positive</b>
	<b>Total</b>	<b>68</b>	<b>Positive</b>

Table 10: Evaluation of the Environmental Element.



## **Bibliography**

- DYNAMIC GROUND WATER RESOURCES OF INDIA (2013) Central Ground Water Board, Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India
- Hydrological framework and ground water management plan of NCT-Delhi (2006) Central Ground Water Board, Government of India
- STATUS, REVIVAL AND GREENING OF WATER BODIES IN DELHI, Delhi Parks & Gardens Society, Department of Environment, Govt. of NCT of Delhi
- [www.gsi.gov.in](http://www.gsi.gov.in)
- [www.bhuvan.nrsc.gov.in](http://www.bhuvan.nrsc.gov.in)
- [www.india-wris.nrsc.gov.in](http://www.india-wris.nrsc.gov.in)
- [www.imd.gov.in](http://www.imd.gov.in)
- [www.dda.org.in](http://www.dda.org.in)
- [www.moef.nic.in](http://www.moef.nic.in)
- [www.huda.org.in](http://www.huda.org.in)



## 5 FLORA AND FAUNA

### 5.1 Birds of NBS

The Najafgarh Jheel has proved to be one of the prominent remaining habitats of migratory birds especially Greater Flamingos. As per the recent census of Asian Waterbird Committee (AWC) on Najafgarh Jheel, there is an almost 135% increase in number of birds and as compared to 2017, 21% increase has been shown in the number of species at the Jheel.

#### Census data:

Data recorded	2017	2018
Total number of birds	3091	1317
Total number of species	33	40

- 19 out of 40 species recorded this year are of resident water birds, including local migratory birds
- 21 out of 40 are winter migratory water birds which includes four species of IUCN Red-listed threatened species such as Woolly-necked Stork, Painted Stork, Black-headed Ibis and Black-necked Stork.
- Some of the species spotted are Bar-headed Geese, graylag Geese, Black-tailed Godwit, Greater Flamingo, Black-winged Stilt, Common Teal, Northern Shoveler and Ruff.

Table 11: Najafgarh Jheel Birds list with their IUCN red listing.

SI no	SCIENTIFIC NAME	COMMON NAME	IUCN	RESIDENTIAL STATUS
1	<i>Accipiter badius</i>	Shikra	LC	
2	<i>Accipiter nisus</i>	Eurasian Sparrowhawk	LC	
3	<i>Acridotheres ginginianus</i>	Bank Myna	LC	
4	<i>Acridotheres tristis</i>	Common Myna	LC	
5	<i>Acrocephalus dumetorum</i>	Blyth's Reed-warbler	LC	
6	<i>Acrocephalus stentoreus</i>	Clamorous Reed-warbler	LC	
7	<i>Actitis hypoleucos</i>	Common Sandpiper	LC	R/W/M
8	<i>Alauda gulgula</i>	Oriental Skylark	LC	
9	<i>Alcedo atthis</i>	Common Kingfisher	LC	R/W/M/SM
10	<i>Amandava amandava</i>	Red Avadavat	LC	



11	<i>Anas acuta</i>	Northern Pintail	LC	WM
12	<i>Anas crecca</i>	Common Teal	LC	WM
13	<i>Anas platyrhynchos</i>	Mallard	LC	R/WM
14	<i>Anas poecilorhyncha</i>	Indian Spot-billed Duck	LC	R/LM
15	<i>Anastomus oscitans</i>	Asian Openbill	LC	R/LM
16	<i>Anhinga melanogaster</i>	Oriental Darter	NT	R/LM
17	<i>Anser albifrons</i>	Greater White-fronted Goose	LC	WM
18	<i>Anser anser</i>	Greylag Goose	LC	WM
19	<i>Anser indicus</i>	Bar-headed Goose	LC	R/WM
20	<i>Anthropoides virgo</i>	Demoiselle Crane	LC	WM
21	<i>Anthus campestris</i>	Tawny Pipit	LC	WM
22	<i>Anthus roseatus</i>	Rosy Pipit	LC	R/AM/WM
23	<i>Anthus similis</i>	Long-billed Pipit	LC	R/WM
24	<i>Anthus spinoletta</i>	Water Pipit	LC	WM
25	<i>Anthus trivialis</i>	Tree Pipit	LC	WM
26	<i>Antigone antigone</i>	Sarus Crane	VU	R/LM
27	<i>Aquila chrysaetos</i>	Golden Eagle	LC	
28	<i>Aquila fasciata</i>	Bonelli's Eagle	LC	
29	<i>Aquila heliaca</i>	Eastern Imperial Eagle	VU	WM
30	<i>Aquila nipalensis</i>	Steppe Eagle	EN	WM
31	<i>Ardea alba</i>	Great White Egret	LC	R/LM
32	<i>Ardea cinerea</i>	Grey Heron	LC	R/WM
33	<i>Ardea intermedia</i>	Intermediate Egret	LC	R/WM
34	<i>Ardea purpurea</i>	Purple Heron	LC	R/LM
35	<i>Ardeola grayii</i>	Indian Pond-heron	LC	R/LM
36	<i>Argya caudata</i>	Common Babbler	LC	R
37	<i>Argya earlei</i>	Striated Babbler	LC	R
38	<i>Argya malcolmi</i>	Large Grey Babbler	LC	R
39	<i>Athene brama</i>	Spotted Owlet	LC	
40	<i>Aythya ferina</i>	Common Pochard	VU	WM
41	<i>Aythya fuligula</i>	Tufted Duck	LC	WM
42	<i>Aythya nyroca</i>	Ferruginous Duck	NT	R/WM
43	<i>Bubo bengalensis</i>	Rock Eagle-owl	LC	
44	<i>Bubulcus ibis</i>	Cattle Egret	LC	R/AM
45	<i>Burhinus indicus</i>	Indian Thick-knee	LC	
46	<i>Butastur teesa</i>	White-eyed Buzzard	LC	
47	<i>Buteo buteo</i>	Eurasian Buzzard	LC	
48	<i>Buteo rufinus</i>	Long-legged Buzzard	LC	
49	<i>Butorides striata</i>	Green-backed Heron	LC	
50	<i>Calidris pugnax</i>	Ruff	LC	WM/PM
51	<i>Calidris pygmaea</i>	Spoon-billed Sandpiper	CR	NE
52	<i>Carpodacus erythrinus</i>	Common Rosefinch	LC	
53	<i>Cecropis daurica</i>	Red-rumped Swallow	LC	
54	<i>Ceryle rudis</i>	Pied Kingfisher	LC	R
55	<i>Chaetornis striata</i>	Bristled Grassbird	VU	
56	<i>Charadrius alexandrinus</i>	Kentish Plover	LC	R/WM
57	<i>Charadrius dubius</i>	Little Ringed Plover	LC	R/WM



58	<i>Charadrius mongolus</i>	Lesser Sandplover	LC	R/WM
59	<i>Chlidonias hybrida</i>	Whiskered Tern	LC	
60	<i>Chrysomma sinense</i>	Yellow-eyed Babbler	LC	NE
61	<i>Ciconia episcopus</i>	White necked stork	VU	R
62	<i>Cinnyris asiaticus</i>	Purple Sunbird	LC	
63	<i>Circaetus gallicus</i>	Short-toed Snake-eagle	LC	NE
64	<i>Circus aeruginosus</i>	Western Marsh-harrier	LC	WM
65	<i>Cisticola juncidis</i>	Zitting Cisticola	LC	
66	<i>Clamator jacobinus</i>	Jacobin Cuckoo	LC	NE
67	<i>Clanga clanga</i>	Greater Spotted Eagle	VU	
68	<i>Clanga hastata</i>	Indian Spotted Eagle	VU	
69	<i>Copsychus saularis</i>	Oriental Magpie-robin	LC	
70	<i>Coracias benghalensis</i>	Indian Roller	LC	
71	<i>Coracias garrulus</i>	European Roller	LC	
72	<i>Corvus macrorhynchos</i>	Large-billed Crow	LC	
73	<i>Corvus splendens</i>	House Crow	LC	
74	<i>Cuculus canorus</i>	Common Cuckoo	LC	
75	<i>Culicicapa ceylonensis</i>	Grey-head Canary-flycatcher	LC	
76	<i>Cursorius coromandelicus</i>	Indian Courser	LC	
77	<i>Cyanecula svecica</i>	Bluethroat	LC	
78	<i>Dendrocitta vagabunda</i>	Rufous Treepie	LC	
79	<i>Dendrocygna javanica</i>	Lesser Whistling-duck	LC	R/LM
80	<i>Dicrurus caerulescens</i>	White-bellied Drongo	LC	
81	<i>Dicrurus leucophaeus</i>	Ashy Drongo	LC	
82	<i>Dicrurus macrocercus</i>	Black Drongo	LC	NE
83	<i>Dinopium benghalense</i>	Black-rumped Flameback	LC	
84	<i>Egretta garzetta</i>	Little Egret	LC	R/LM
85	<i>Elanus caeruleus</i>	Black-winged Kite	LC	
86	<i>Emberiza bruniceps</i>	Red-headed Bunting	LC	
87	<i>Emberiza lathami</i>	Crested Bunting	LC	
88	<i>Emberiza stewarti</i>	White-capped Bunting	LC	
89	<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	NT	R
90	<i>Eremopterix griseus</i>	Ashy-crowned Sparrow-lark	LC	
91	<i>Eudynamis scolopaceus</i>	Western Koel	LC	NE
92	<i>Eumyias thalassinus</i>	Verditer Flycatcher	LC	
93	<i>Euodice malabarica</i>	Indian Silverbill	LC	
94	<i>Falco chicquera</i>	Red-headed Falcon	NT	
95	<i>Falco peregrinus</i>	Peregrine Falcon	LC	R/WM
96	<i>Falco subbuteo</i>	Eurasian Hobby	LC	
97	<i>Falco tinnunculus</i>	Common Kestrel	LC	
98	<i>Ficedula albicilla</i>	Red-throated Flycatcher	LC	
99	<i>Ficedula parva</i>	Red-breasted Flycatcher	LC	
100	<i>Francolinus francolinus</i>	Black Francolin	LC	



101	<i>Francolinus pondicerianus</i>	Grey Francolin	LC	NE
102	<i>Fulica atra</i>	Common Coot	LC	R/W/M
103	<i>Galerida cristata</i>	Crested Lark	LC	
104	<i>Gallinago gallinago</i>	Common Snipe	LC	R/W/M
105	<i>Gallinula chloropus</i>	Common Moorhen	LC	R/W/M
106	<i>Gelochelidon nilotica</i>	Common Gull-billed Tern	LC	R/W/M
107	<i>Glareola lactea</i>	Little Pratincole	LC	R/LM
108	<i>Glareola maldivarum</i>	Oriental Pratincole	LC	R/LM/SM
109	<i>Gracupica contra</i>	Asian Pied Starling	LC	
110	<i>Grus grus</i>	Common Crane	LC	WM
111	<i>Gymnoris xanthocollis</i>	Yellow-throated Sparrow	LC	
112	<i>Halcyon smyrnensis</i>	White-breasted Kingfisher	LC	R/LM
113	<i>Hieraaetus pennatus</i>	Booted Eagle	LC	
114	<i>Hierococcyx varius</i>	Common Hawk-cuckoo	LC	
115	<i>Himantopus himantopus</i>	Black-winged Stilt	LC	R/LM
116	<i>Hirundo rustica</i>	Barn Swallow	LC	WM
117	<i>Hirundo smithii</i>	Wire-tailed Swallow	LC	R/SM
118	<i>Hydrophasianus chirurgus</i>	Pheasant-tailed Jacana	LC	R/LM/SM
119	<i>Iduna caligata</i>	Booted Warbler	LC	R
120	<i>Iduna rama</i>	Sykes's Warbler	LC	R
121	<i>Ixobrychus cinnamomeus</i>	Cinnamon Bittern	LC	R/LM
122	<i>Ixobrychus flavicollis</i>	Black Bittern	LC	R/LM
123	<i>Ixobrychus sinensis</i>	Yellow Bittern	LC	R/LM
124	<i>Jynx torquilla</i>	Eurasian Wryneck	LC	
125	<i>Lanius cristatus</i>	Brown Shrike	LC	
126	<i>Lanius isabellinus</i>	Isabelline Shrike	LC	
127	<i>Lanius meridionalis</i>	Iberian Grey Shrike	VU	
128	<i>Lanius schach</i>	Long-tailed Shrike	LC	NE
129	<i>Lanius vittatus</i>	Bay-backed Shrike	LC	
130	<i>Larus fuscus</i>	Lesser Black-backed Gull	LC	WM
131	<i>Larus ridibundus</i>	Black-headed Gull	LC	WM
132	<i>Limosa limosa</i>	Black-tailed Godwit	NT	WM
133	<i>Lonchura punctulata</i>	Scaly-breasted Munia	LC	
134	<i>Lymnocyptes minimus</i>	Jack Snipe	LC	WM
135	<i>Mareca penelope</i>	Eurasian Wigeon	LC	WM
136	<i>Mareca strepera</i>	Gadwall	LC	WM
137	<i>Merops orientalis</i>	Asian Green Bee-eater	LC	NE
138	<i>Merops persicus</i>	Blue-cheeked Bee-eater	LC	SM/PM
139	<i>Merops philippinus</i>	Blue-tailed Bee-eater	LC	R/W/M
140	<i>Metopidius indicus</i>	Bronze-winged Jacana	LC	R
141	<i>Microcarbo niger</i>	Little Cormorant	LC	R/LM
142	<i>Milvus migrans</i>	Black Kite	LC	
143	<i>Mirafra assamica</i>	Bengal Bushlark	LC	



144	<i>Mirafra erythroptera</i>	Indian Bushlark	LC	
145	<i>Monticola solitarius</i>	Blue Rock-thrush	LC	
146	<i>Motacilla maderaspatensis</i>	White-browed Wagtail	LC	R
147	<i>Mycteria leucocephala</i>	Painted Stork	NT	R/LM
148	<i>Neophron percnopterus</i>	Egyptian Vulture	EN	
149	<i>Nettapus coromandelianus</i>	Cotton Pygmy-goose	LC	R/LM
150	<i>Numenius arquata</i>	Eurasian Curlew	NT	WM
151	<i>Numenius phaeopus</i>	Whimbrel	LC	WM
152	<i>Nycticorax nycticorax</i>	Black-Crowned Night Heron	LC	R/LM
153	<i>Ocyrceros birostris</i>	Indian Grey Hornbill	LC	NE
154	<i>Oenanthe fusca</i>	Brown Rockchat	LC	
155	<i>Oenanthe picata</i>	Variable Wheatear	LC	
156	<i>Oriolus kundoo</i>	Indian Golden Oriole	LC	
157	<i>Orthotomus sutorius</i>	Common Tailorbird	LC	
158	<i>Passer domesticus</i>	House Sparrow	LC	
159	<i>Passer hispaniolensis</i>	Spanish Sparrow	LC	
160	<i>Passer pyrrhonotus</i>	Sind Sparrow	LC	
161	<i>Pastor roseus</i>	Rosy Starling	LC	
162	<i>Pavo cristatus</i>	Indian Peafowl	LC	
163	<i>Pelecanus onocrotalus</i>	Great White Pelican	LC	R/WM
164	<i>Pericrocotus ethologus</i>	Long-tailed Minivet	LC	
165	<i>Pernis ptilorhynchus</i>	Oriental Honey-buzzard	LC	
166	<i>Petrochelidon fluvicola</i>	Streak-throated Swallow	LC	
167	<i>Phalacrocorax carbo</i>	Great Cormorant	LC	R/WM
168	<i>Phalacrocorax fuscicollis</i>	Indian Cormorant	LC	R/LM
169	<i>Phoenicopterus roseus</i>	Greater Flamingo	LC	R/WM/LM
170	<i>Phoenicurus ochruros</i>	Black Redstart	LC	R/WM/AM

## LEGEND

RESIDENTIAL STATUS		IUCN Red List Categories	
R	Resident	EX	Extinct
R/LM	Resident with local movements	EW	Extinct in the Wild
R/AM	Resident with altitudinal movements	CR	Critically Endangered
R/WM	Resident with winter influx	EN	Endangered
R/WM/LM	Resident with winter influx and local movements	VU	Vulnerable
WM	Winter Migrant	NT	Near Threatened
WM/R	Largely winter migrant and partly resident	LC	Least Concern
WM/PM	Winter migrant as well as passage migrant	DD	Data Deficient
NE	Not Evaluated	NE	Not Evaluated



## 5.2 Vegetation of NBS

Natural landscape plays a major role in enhancing the social, economic, cultural, ecological well-being. Moreover, it provides the opportunity for people to escape the pressure of modern living and to get back in touch with nature by refreshing their mind and soul. Accessible natural landscape significantly increases the quality of life in urban lifestyle.

### Existing species at Najafgarh Bird Sanctuary

S.No	Botanical Name	Common Name	Habit	Habitat
1	<i>Acacia leucophloea</i>	Reonja	Tree	Terrestrial
2	<i>Acacia nilotica</i>	Babool	Tree	Terrestrial
3	<i>Eucalyptus globulus</i>	Eucalptus	Tree	Terrestrial
4	<i>Prosopis juliflora</i>	Vilaithi Kikar	Tree	Terrestrial
5	<i>Ficus elastica</i>	India Rubber	Tree	Terrestrial
6	<i>Azadirachta indica</i>	Neem	Shrubs	Terrestrial
7	<i>Carissa spinarum</i>	Sinhala	Shrubs	Terrestrial
8	<i>Zizyphus nummularia</i>	Jharber	Shrubs	Terrestrial
9	<i>Leucaena leucocephala</i>	Wild Tamarind	Shrubs	Terrestrial
10	<i>Eichornia crassipes</i>	Water Hyacinth	Water Plant	Aquatic
11	<i>Lemna minor</i>	Duckweed	Water Plant	Aquatic
12	<i>Leptochloa chinesis</i>	Water Grass	Water Plant	Aquatic

Table 12: Existing Vegetation at NBS





**List of proposed Trees and shrubs for Najafgarh Bird Sanctuary:**

S.N	Botanical Name	Common Name	Habit	Habitat
1	<i>Polyalthia longifolia</i>	Ashok	Tree	Terrestrial
2	<i>Salvadora persica</i>	Peelu	Small tree	Terrestrial
3	<i>Ehretia acuminata</i>	Silky ash	Small tree	Terrestrial
4	<i>Ficus benjamina</i>	Weeping Fig	Tree	Terrestrial
5	<i>Ficus benghalensis</i>	Banyan	Tree	Terrestrial
6	<i>Morus alba</i>	Shahtoot	Small tree	Terrestrial
7	<i>Drypetes roxburghii</i>	Putranjiva	Tree	Terrestrial
8	<i>Nyctanthes arbor-tristis</i>	Harshingar	Bush	Terrestrial
9	<i>Mimusops elengi</i>	Spanish Cherry	Tree	Terrestrial
10	<i>Lagerstroemia speciosa</i>	Jarul	Small tree	Terrestrial
11	<i>Lagerstroemia indica</i>	Crape myrtle	Small tree	Terrestrial
12	<i>Ziziphus mauritiana</i>	Ber	Small tree	Terrestrial
13	<i>Neolamarckia cadamba</i>	Kadamb	Tree	Terrestrial
14	<i>Cassia fistula</i>	Amaltas	Tree	Terrestrial
15	<i>Syzigium cumini</i>	Jamun	Tree	Terrestrial
16	<i>Punica granatum</i>	Anar	Tree	Terrestrial
17	<i>Mangifera indica</i>	Mango	Tree	Terrestrial
18	<i>Tabernaemontana divaricata</i>	Chandni	Small tree	Terrestrial
19	<i>Plumeria rubra</i>	Frangipani	Small tree	Terrestrial
20	<i>Plumeria obtusa</i>	White Frangipani	Small tree	Terrestrial



21	<i>Ficus virens</i>	Pilkhan	Tree	Terrestrial
22	<i>Alstonia scholaris</i>	Saptaparni	Tree	Terrestrial
23	<i>Pterospermum acerifolium</i>	Kanak Champa	Tree	Terrestrial
24	<i>Thevetia peruviana</i>	Peeli kaner	Small tree	Terrestrial
25	<i>Callistemon viminalis</i>	Weeping Bottlebrush	Tree	Terrestrial
26	<i>Bauhinia racemosa</i>	Jhinjheri	Small tree	Terrestrial
27	<i>Bauhinia variegata</i>	Kachnar	Middle size tree	Terrestrial
28	<i>Bauhinia x blakeana</i>	Hong kong orchid tree	Middle tree	Terrestrial
29	<i>Senna siamea</i>	Kassod	Middle tree	Terrestrial
30	<i>Azadirachta indica</i>	Neem	Middle tree	Terrestrial
31	<i>Delonix regia</i>	Gulmohar	Middle tree	Terrestrial
32	<i>Nymphaea alba</i>	White water lily	Flowering	Aquatic

Table 13: Proposed Vegetation at NBS



### 5.3 Avifauna Habitat Mapping of NBS

The avifauna habitat mapping of the site will depend on the ecological zones of the site that the bird favors during their stay in the winter season, the mapping will depend on the bird flight radius and their approach to the parts of the wetland for feeding, roosting and even for breeding purposes for some.

The site caters a large population of the birds from the cranes to even the house sparrows but to top it all the major attraction of the site is the Greater Flamingos which are very uncommon in this part of the region but the population have been thriving their and ever increasing along the years.

The habitats of the site and birds found in the particular zone are listed below:

Table 14: Ecological habitats with Birds found at that zone in NBS

S.No	Scientific name	Birds	
		Scientific name	Common name
1	The deep water zone (Permanent water level)	<i>Anas crecca</i>	Common Teal
		<i>Anas platyrhynchos</i>	Mallard
		<i>Anser indicus</i>	Bar-headed Goose
		<i>Ardeola grayii</i>	Indian Pond-heron
		<i>Aythya ferina</i>	Common Pochard
		<i>Bubulcus ibis</i>	Cattle Egret
		<i>Calidris pugnax</i>	Ruff
		<i>Ciconia episcopus</i>	White necked stork
		<i>Fulica atra</i>	Common Coot
		<i>Gallinago gallinago</i>	Common Snipe
		<i>Grus grus</i>	Common Crane
2	Marshes	<i>Anas acuta</i>	Northern Pintail
		<i>Anhinga melanogaster</i>	Oriental Darter
		<i>Anser albifrons</i>	Greater White-fronted Goose
		<i>Anthropoides virgo</i>	Demoiselle Crane
		<i>Ardea cinerea</i>	Grey Heron
		<i>Dendrocygna javanica</i>	Lesser Whistling-duck
		<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork
		<i>Lanius schach</i>	Long-tailed Shrike
		<i>Microcarbo niger</i>	Little Cormorant
		<i>Phalacrocorax carbo</i>	Great Cormorant
		<i>Phoenicopterus roseus</i>	Greater Flamingo
<i>Plegadis falcinellus</i>	Glossy Ibis		



3	Shallow water/ The full supply level zone (Seasonal water level)	<i>Anas acuta</i>	Northern Pintail
		<i>Anas crecca</i>	Common Teal
		<i>Ardea cinerea</i>	Grey Heron
		<i>Ciconia episcopus</i>	White necked stork
		<i>Egretta garzetta</i>	Little Egret
		<i>Himantopus himantopus</i>	Black-winged Stilt
		<i>Hirundo rustica</i>	Barn Swallow
		<i>Mareca penelope</i>	Eurasian Wigeon
		<i>Numenius arquata</i>	Eurasian Curlew
		<i>Spatula querquedula</i>	Garganey
4	High Flood Level / Littoral zone	<i>Antigone antigone</i>	Sarus Crane
		<i>Ardea cinerea</i>	Grey Heron
		<i>Bubulcus ibis</i>	Cattle Egret
		<i>Egretta garzetta</i>	Little Egret
		<i>Grus grus</i>	Common Crane
		<i>Ploceus philippinus</i>	Baya Weaver
5	Dense vegetation	<i>Anhinga melanogaster</i>	Oriental Darter
		<i>Ardea cinerea</i>	Grey Heron
		<i>Ardea purpurea</i>	Purple Heron
		<i>Ardeola grayii</i>	Indian Pond-heron
		<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork
		<i>Lanius schach</i>	Long-tailed Shrike
		<i>Merops orientalis</i>	Asian Green Bee-eater
		<i>Numenius arquata</i>	Eurasian Curlew
		<i>Ocyrceros birostris</i>	Indian Grey Hornbill
		<i>Ploceus philippinus</i>	Baya Weaver
		<i>Threskiornis melanocephalus</i>	Black-headed Ibis
6	Agricultural lands	<i>Anthropoides virgo</i>	Demoiselle Crane
		<i>Antigone antigone</i>	Sarus Crane
		<i>Aquila nipalensis</i>	Steppe Eagle
		<i>Ardea alba</i>	Great White Egret
		<i>Ardea purpurea</i>	Purple Heron
		<i>Calidris pygmaea</i>	Spoon-billed Sandpiper
		<i>Chrysomma sinense</i>	Yellow-eyed Babbler
		<i>Ciconia episcopus</i>	White necked stork
		<i>Circaetus gallicus</i>	Short-toed Snake-eagle
		<i>Clamator jacobinus</i>	Jacobin Cuckoo
		<i>Francolinus pondicerianus</i>	Grey Francolin
		<i>Merops orientalis</i>	Asian Green Bee-eater
		<i>Ploceus benghalensis</i>	Black-breasted Weaver



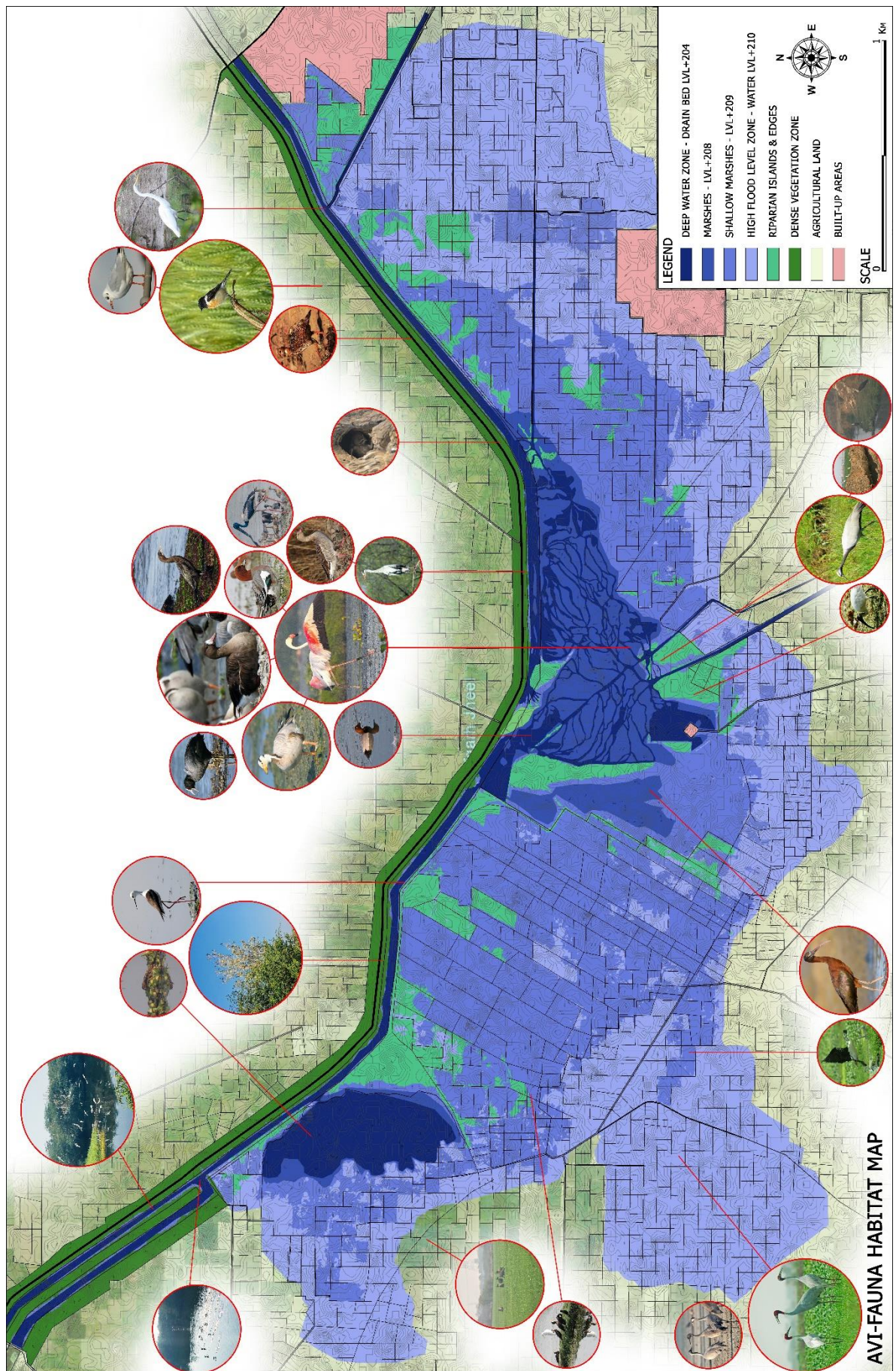


Figure 36: Avi-Fauna Habitat map of the Najafgarh Jheel.



## 5.4 Migratory Pattern

The main migratory pattern that follows in this area is observed by birds that come to Indian Subcontinent during the winters, birds from central Asian region of Kazakhstan, Mongolia and Russia and from the Tibetan region make wetlands, rivers, streams, lakes, coastal areas, and farmlands in this subcontinent their home during the winter period. While some just visit and go back after winters most of the birds even breed in the wintering range.

**THE CENTRAL ASIAN FLYWAY**, the zone which is the shortest in the world lies entirely in the Eurasian zone which caters and connects the large Palearctic swathe to the Indian subcontinent, the Himalayas which is avoided by some birds who travel past it, while birds like Bar Headed Goose follow a route directly above it and are the world's highest altitude migrant which are capable of crossing even the Mount Everest.

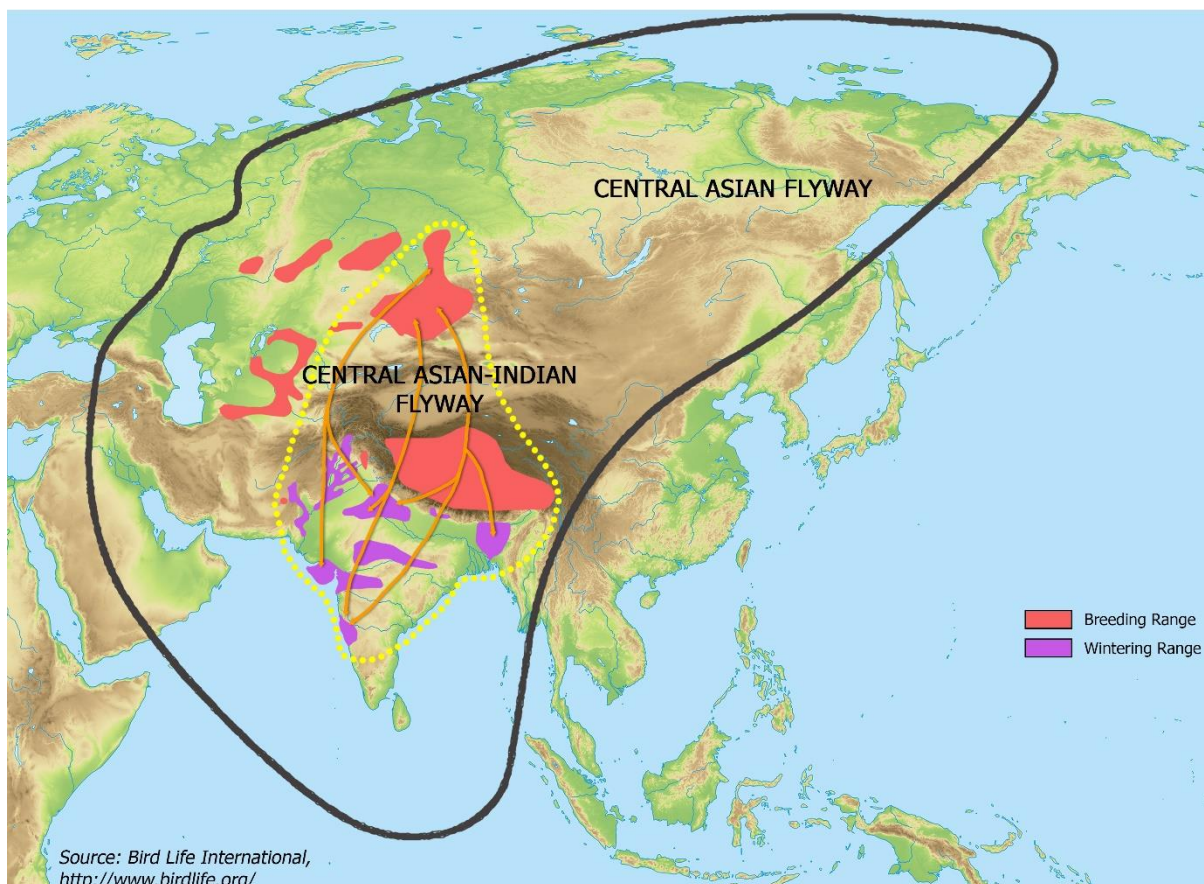


Figure 37: Bird life international image showing the central Asian flyway.

## **Bibliography**

- Asian Waterbird Census, 2018
- [www.south-asia.wetlands.org](http://www.south-asia.wetlands.org)
- [www.birdcount.in](http://www.birdcount.in)
- [www.iucn.org](http://www.iucn.org)
- [www.sacon.in](http://www.sacon.in)
- [www.bnhs.org](http://www.bnhs.org)
- [www.moef.nic.in](http://www.moef.nic.in)
- [www.delhibird.com](http://www.delhibird.com)
- [www.indianwildlifeclub.com](http://www.indianwildlifeclub.com)
- [www.birdlife.org](http://www.birdlife.org)

## 6 CASE STUDY

### 6.1 Keoladeo National Park

#### 6.1.1 About the Park

Also, popularly known as Bharatpur National Park or Ghana National Park located in the state of Rajasthan. Bharatpur National Park, formerly famous for duck-hunting reserve for the Maharajas is one of the major migrating areas for large number aquatic birds from Afghanistan, Turkmenistan, China and Siberia. 364 species of birds, including the rare Siberian crane, have been recorded in the park. Keoladeo National Park is an important winter migratory ground of Palearctic waterfowl and is famous for its large assembly of non-migratory resident breeding birds.

Approximately 375 bird species and a diverse array of other life forms have been recorded in this variegation of grasslands, woodlands, woodland swamps and wetlands of 2,873 ha.

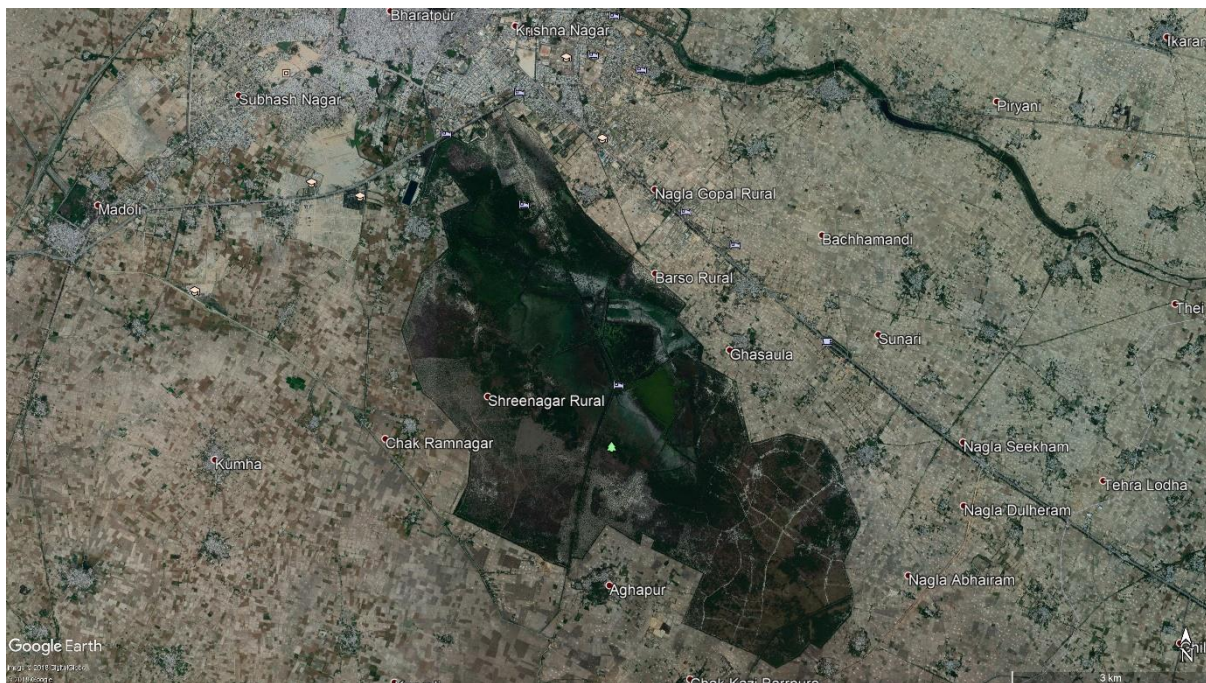


Figure 38: Google earth image of the Keoladeo National Park.



### **6.1.2 Location**

Keoladeo national park lies between 27°7'06" N – 27°12'02" N latitude and 77°29'05' E – 77°33'09" E longitude with an elevation of 572 m above mean sea level.

### **6.1.3 Topography**

The approx. area of KNP is 29 sqm and is a low-lying area with a gentle slope towards the center. The total wetland area is approximately 6 sq. km. Various unequal compartments has been made in the submerged area by means of dykes. A metaled road, which is now closed to traffic, passes directly through the park.

### **6.1.4 Soil**

Soil type at KNP is thick alluvium which is generally overlying by kanker path and some clay formation. The periodic inundation is dominant in the area. Patchy saline soil are common in the terrestrial area.

### **6.1.5 Climatic Condition**

The climate of the region is hot in the summer, hot & humid in monsoon season, followed by cold and foggy in the winter season.

### **6.1.6 Rainfall**

Southwest monsoon is mainly responsible for the precipitation in Bharatpur National Park, which usually starts in the end of month Jun or early Jul and extends up to Sept, sometimes to even Oct.

### **6.1.7 Flora and Fauna**

#### **Dominant Flora:**

Kadam (*Mitragyna parvifolia*), Kandi (*Prosopis cineraria*), Ber (*Zizyphus*), Kair (*Capparis decidua*), Jamun (*Syzygium cumini*), Pилоo (*Salvadora oleoides*) Babul (*Acacia nilotica*), etc.

### Dominant Fauna:

Birds – Painted Stork, cormorant, egret, Sociable Lapwing, Indian Courser, Imperial, Spotted Eagles, Darters, Demoiselle Cranes, Black-headed Ibis, Darter, Shoveller, teal, Dalmatian Pelicans, Black Bittern, Greater Painted Snipe, Large-tailed, Dusky Eagle Owls, spoonbills, kingfishers, warblers, partridges, several species of egrets, herons, geese, pelicans, cormorants, ducks, Lager falcon, greater-spotted falcon, Pallas' eagle etc.

Mammals – Jackals, Chital, Sambar, Nilgai, Wild cats, Hyenas, Wild boar, Indian porcupine, Mongoose, Fishing cats

Reptiles – Indian rock pythons, common kraits, blind snakes, checkered keel backs, Russell's vipers, sand boas, common cobras, common monitor lizards, Calotes, skinks, common wolf-snakes, turtles etc.

Migrants – Siberian Crane, Steppe Eagle, Pale and Marsh Harriers, Osprey, Common Teal, Indian Little Ringed Plover etc.



Figure 39: Photographs of some of the birds and animals in the park.

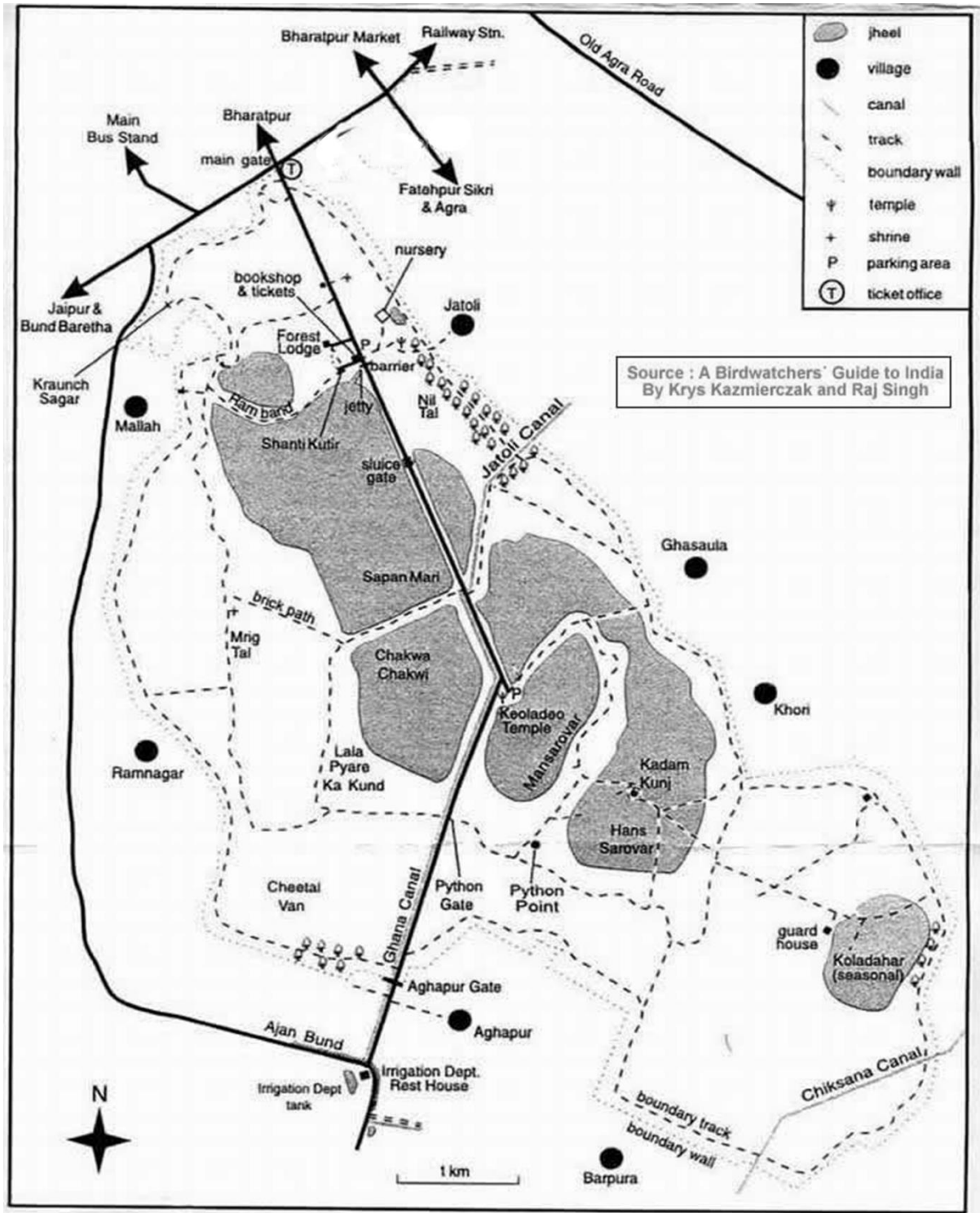


Figure 40: Bird watchers guide to India's plan of the national park.



### **6.1.8 Importance**

The only known wintering site of critically endangered Siberian Crane is Keoladeo National Park. It also serves as a wintering area for other globally threatened species such as the Imperial Eagle and Greater Spotted Eagle.

During the breeding season, 15 species of heron, ibis, cormorants, spoonbills and storks forms the most astounding heronry in the region.

This is the only park in India which is completely enclosed by a 2 m high boundary wall. This wall minimises the possibilities of any encroachment or biotic disturbances, but there is no possibility of a buffer zone.

### **6.1.9 Issues**

Water supply, invasive vegetation (Prosopis, Eichhornia, Paspalum) and inappropriate use of the property by nearby areas are the major threats to the area. The wetlands of Keoladeo are dependent on the monsoon or water pumped in from outside (from Ajan Bandh) and are thus not natural. Since, the area faces water shortage because of erratic rainfall thus, the problem will be addressed by initiating two large water resources projects that will bring water from permanent water sources in the region.



**Figure 41: Photographs of the National park.**

## 6.2 Okhla Bird Sanctuary

### 6.2.1 About the Park

Okhla Bird Sanctuary is a declared bird sanctuary in 1990 and situated at the Okhla barrage over Yamuna River in Noida and known as haven for 300 bird species especially water birds.

The Okhla Bird Sanctuary (OBS) is approximately 4 square kilometers in size and is one among 15 bird sanctuaries in the state.

Delhi being home to around 500 species of birds makes it the world's second most bird-rich city after Kenya's capital Nairobi.

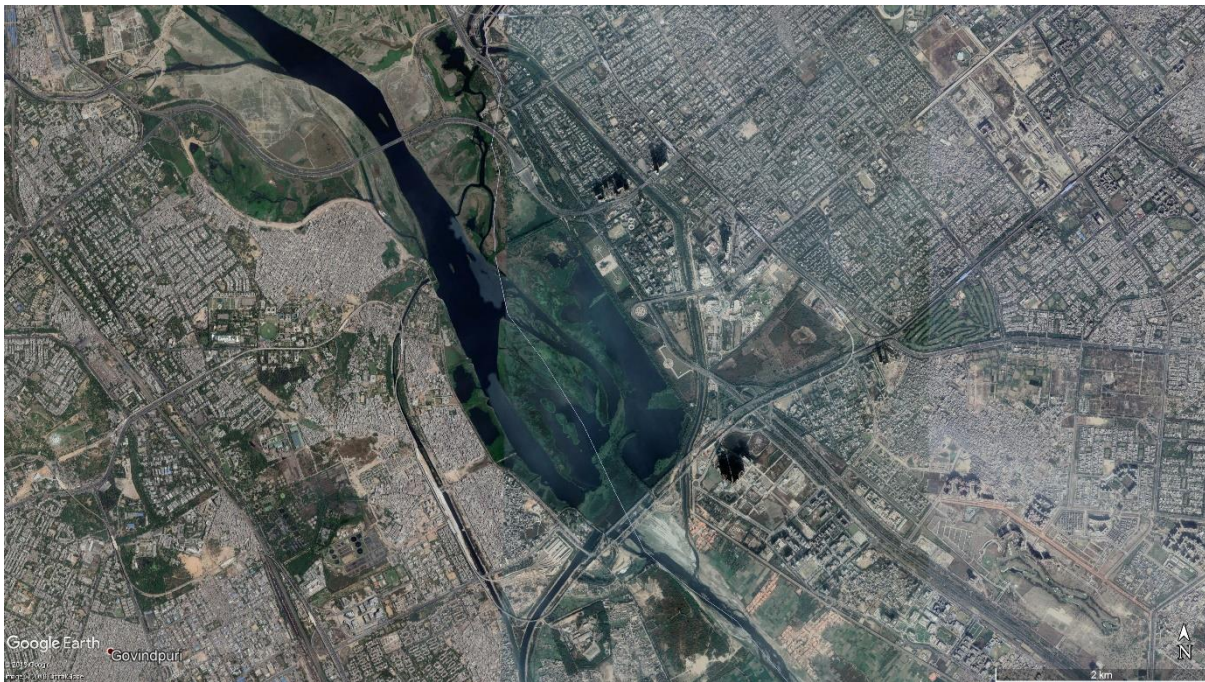


Figure 42: Google earth image of the Okhla Bird Sanctuary.

### 6.2.2 Location

The site is located at the point where the river enters Uttar Pradesh. The most prominent feature of the sanctuary is the large lake created by damming the river, which lies between Okhla village to the west and Gautam Budh Nagar to the east.

### 6.2.3 Topography

Delhi is bounded by the Indo-Gangetic alluvial plains in the North and East, the Thar Desert in the West and by Aravalli hill ranges in the South. The terrain of Delhi is flat in general except for a low NNE-SSW trending ridge that is considered an extension of the Aravalli hills of Rajasthan. The ridge may be said to enter Delhi from the SW.

### 6.2.4 Soil

Soil type of the area is mainly Indo-Gangetic alluvial soil.

### 6.2.5 Climatic Condition

The climate is hot in the summer, hot humid in monsoon, cold and foggy in the winter. The annual temperature varies from 2° C to 45 °C.

### 6.2.6 Rainfall

The monsoon season in Delhi lasts from July to September. Sometimes October sees the end of the monsoon. Precipitation is also at the highest in July and August.

### 6.2.7 Flora and Fauna

#### Dominant Flora:

The water body is mainly covered in patches by Water hyacinth *Eichhornia crassipes* and water lettuce *Pistia stratiotes*. Common submerged vegetation includes *Hydrilla verticillata*, *Vallisneria spiralis*, *Potamogeton pectinatus*, *Potamogeton crispus*.

The banks have a variety of 30 different species like Ficus, Babool, Shisham, Semal, Subabool, Keekar and several shrubs (10 species) and herbs (9 climbers, 16 grasses) which provides excellent hiding, and roosting site for birds.



### Dominant Fauna:

Over 350 bird species have been confirmed by the forest officials and over 1 lakh migratory birds have been reported in one season.

- About 10 threatened species of birds have been recorded which includes species of critically endangered (CR) birds and species of nearly threatened (NT).
- More than 320 bird species recorded out of these 20 are common resident water bird species.
- 44 common resident woodland species and 43 migratory water bird's species and 26 migratory woodland bird's species.
- About 10 species of mammals includes nilgai, indian mongoose, blacknaped hare, jackals, 08 species of reptiles, 02 species of amphibians.



Figure 43: OBS website's Photographs of some of the birds and animals in the park.



Figure 44: Trimble data's plan of the Okhla Bird Sanctuary.





### 6.2.8 Importance

Around 400 species in a year-round and over 1 lakh migratory birds in winter months are present in the sanctuary.

It hosts 30% of the 1200 to 1300 bird species recorded in the Indian sub-continent. The area around the Water body provides a safeguard to the hundreds of local and migratory birds and provide a safe sanctuary for their breeding.

### 6.2.9 Issues

Needless to mention that this Sanctuary has been neglected by the government officials, and though being a tourist spot, has not been maintained well.

Local people, who stay in and around that area, bring their own cattle for feeding the grass inside the sanctuary, plus small ponds available inside the sanctuary makes it more convenient place to bring their cattle's.

Construction in nearby areas is on full swing, and gates are not much secured (anyone can jump inside the sanctuary and roam freely).

Main causes for the dwindling of bird population in this area area:

- Felling of trees continuously
- 24 hours bright lights
- heavy traffic over the barrage itself on the Delhi-Noida road
- pollution caused due to sewage and construction, etc.



Figure 45: Photographs of the National park.

## **Bibliography**

- [www.obs-up.com](http://www.obs-up.com)
- [www.en.wikipedia.org/wiki/Okhla\\_Sanctuary](http://www.en.wikipedia.org/wiki/Okhla_Sanctuary)
- [www.bharatpursanctury.com](http://www.bharatpursanctury.com)
- [www.tourism.gov.in](http://www.tourism.gov.in)
- [www.thewildlifeofindia.com/bharatpur-bird-sanctuary.html](http://www.thewildlifeofindia.com/bharatpur-bird-sanctuary.html)



## 7 PROPOSAL STRATEGY: LANDSCAPE

### 7.1 Statutory Provisions

- a) **Section 5 (1) of the “Environment (Protection) Rules, 1986”** vide S.O. 844 (E) dated 19.11.1986 and subsequent amendments states that the central government is allowed to prohibit or restrict the location of industries and its processes and operation from proximity to a protected area under the Ancient monuments and Archaeological Sites and Remains Act, 1958 or a sanctuary, National park, or closed area notified as such under the Wild Life (Protection) Act, 1972. (MOEF, The Environment ( Protection ) Rules, 1986)
- b) **Section 5 C (1) of the Wildlife (Protection) Act, 1972** states that it shall be the duty of the National Board for Wildlife to promote the conservation and development of Wildlife and forests by such measures as it thinks fit. (MOEF, THE WILD LIFE (PROTECTION) ACT, 1972)
- c) **Section 3 of the Environment (Protection) Act, 1986 (EPA)** gives power to the Central Government i.e. the Union Ministry of Environment and Forests to take all measures that it feels are necessary for protecting and improving the quality of the environment and to prevent and control environmental pollution. To meet this objective, the Central Government can restrict areas in which any industries, operations or processes or class of industries, operations or processes shall not be carried out or shall be carried out subject to certain safeguards. (MOEF, The Environment ( Protection ) Rules, 1986)

#### **Purpose for declaring Eco-Sensitive Zones:**

Creating “Shock absorber” for the protected areas is the main purpose of declaring Eco-Sensitive zones around national parks and sanctuaries. They would also show a transition zone from areas of high protection to areas with lesser protection.

The policies of the park will include Eco Sensitive Zone around the wetland from farming practices to drainage solutions. The park will have its own guidelines for the movements, vegetation typology and habitat conservation.



## 7.2 Providing an Identity

Najafgarh Jheel Bird Sanctuary is a proposed wetland which never saw the light of day.

The LOGO is an Identity and first impression of anything that represents the soul and body of the purpose.



Figure 46: Proposed Logo for Najafgarh Bird Sanctuary.

The designed logo represents the rich ecosystem in the wetland and also the most precious gem of the area, the Greater Flamingos.

## **7.2 Boundary Delineation**

The demarcation or delineation of a boundary in terms of a wetlands generally considers the high flood level, but it is generally not considered the major factor when it comes to boundary delineation in case of a Bird Sanctuary.

Ecologically the boundary considers the maximum body of water and covers the habitat of wetland dependent fauna as well so indicators for NBS are the southern side flood line and the farmland bunds, and in the northern side the main indicator is the drain channel or the inspection road.

The use of USGS Landsat images of various months throughout the years and also observing the change in water levels through satellite imagery also played a major role in demarcation of the boundary.

Soil condition, vegetation patterns and hydrological conditions were also considered while demarcating the boundary.

Bird flight radius and their approach to the parts of wetland throughout the winter migration period were also a major consideration.



## 7.2.1 The Yearly Cycle

While looking for a proper demarcation and the present overview of the site the satellite imagery was considered the first option to look into the overall area that gets covered in surface water in the site, for this Google earth was extensively used to demarcate the extent of water spread.

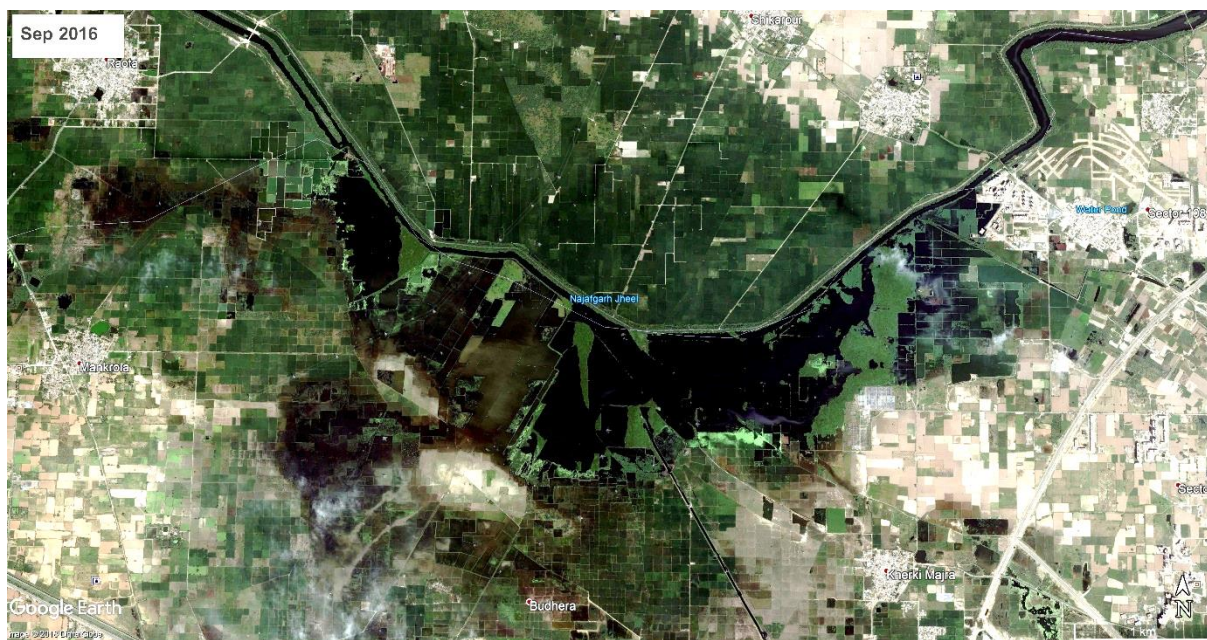


Figure 47: Google Earth image depicts the extent of water during post-monsoons in year 2016.



Figure 48: Google Earth image depicts the extent of water during pre-winters in year 2016.

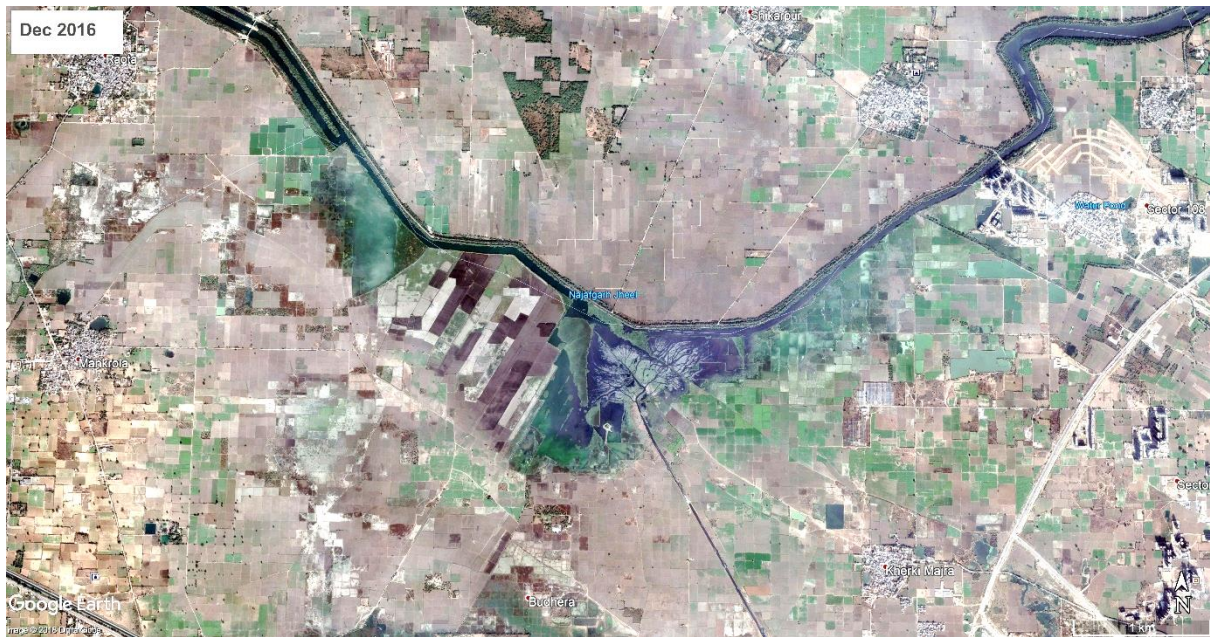


Figure 49: Google Earth image depicts the extent of water during peak-winters in year 2016.

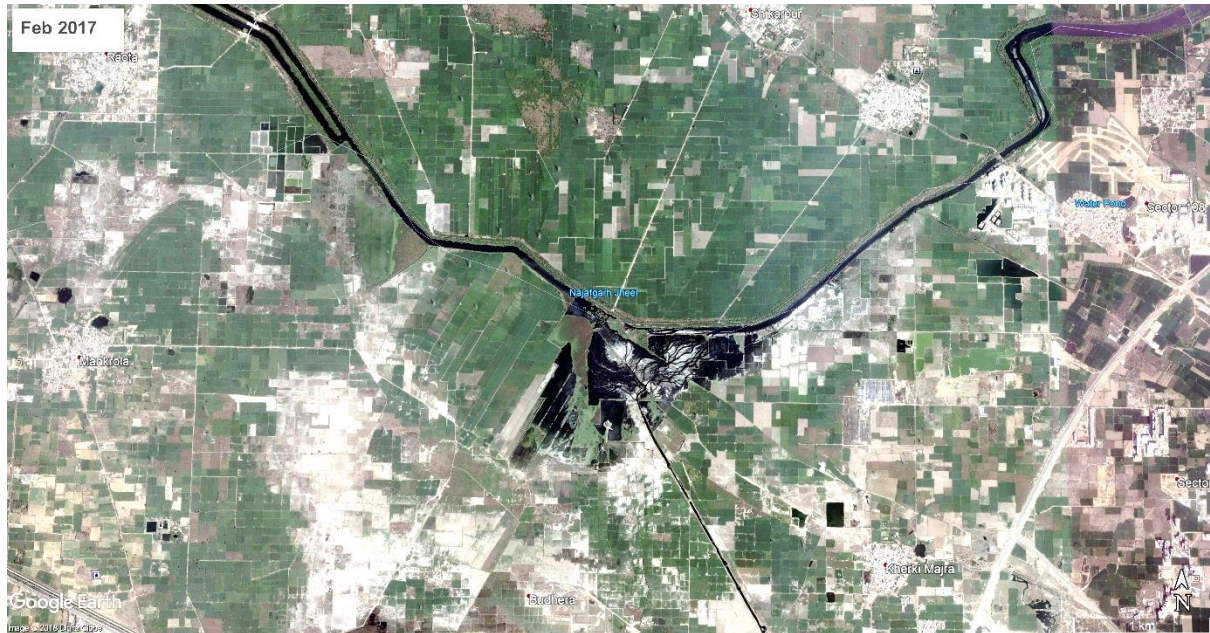


Figure 50: Google Earth image depicts the extent of water during late-winters in year 2017.

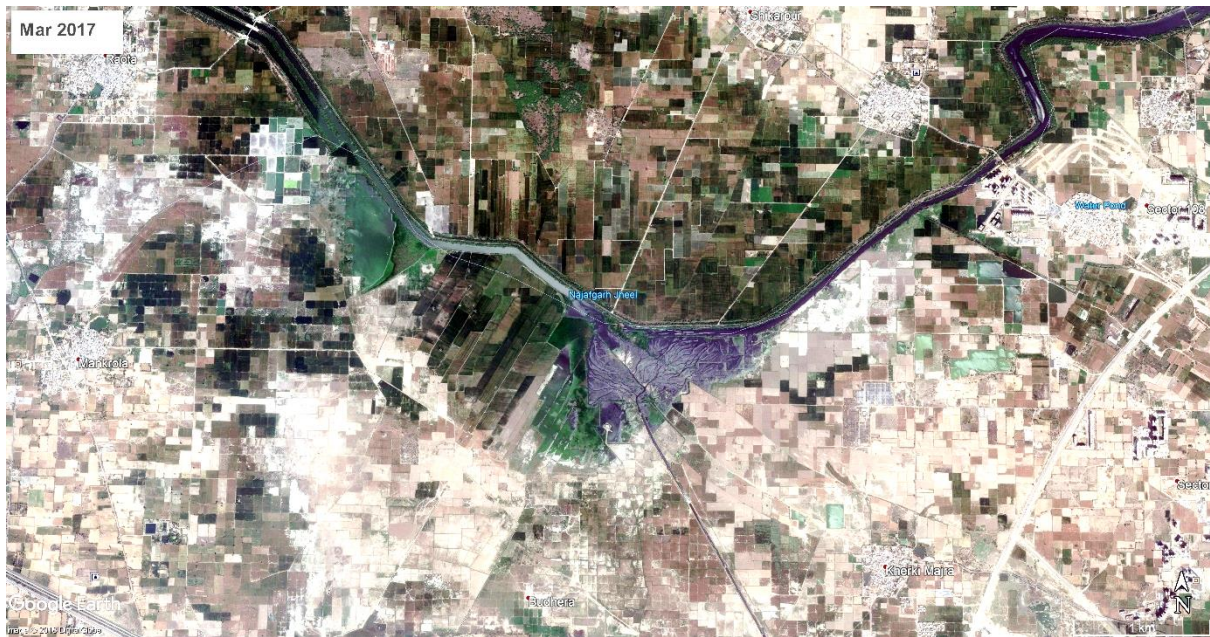


Figure 51: Google Earth image depicts the extent of water during springs in year 2017.



Figure 52: Google Earth image depicts the extent of water during peak-summers in year 2017.





Figure 53: Google Earth image depicts the extent of water post-monsoon in year 2017.

Through these Google earth images one can observe the change in the water spread area in the region, the images even depicts the changes in vegetation typology from one post-monsoons to another post-monsoons time period through the years and decades that have passed. This clearly indicates the presence of a seasonal wetland which revives each monsoons in a cycle that govern the ecosystem in this region.

And the time when the winter migration in the region begins, this wetland comes to its full glory to welcome the visitors to its adobe and provides a shelter till these visitors time to start their journey back home comes.

### 7.2.1 Normalized Difference Vegetation Index (NDVI)

It is a simple graphical indicator which is used to analyse Remote Sensing Measurements from a space platform, for this wetland the imagery has been used to provide a data showing the water surfaces that can be observed throughout the year.

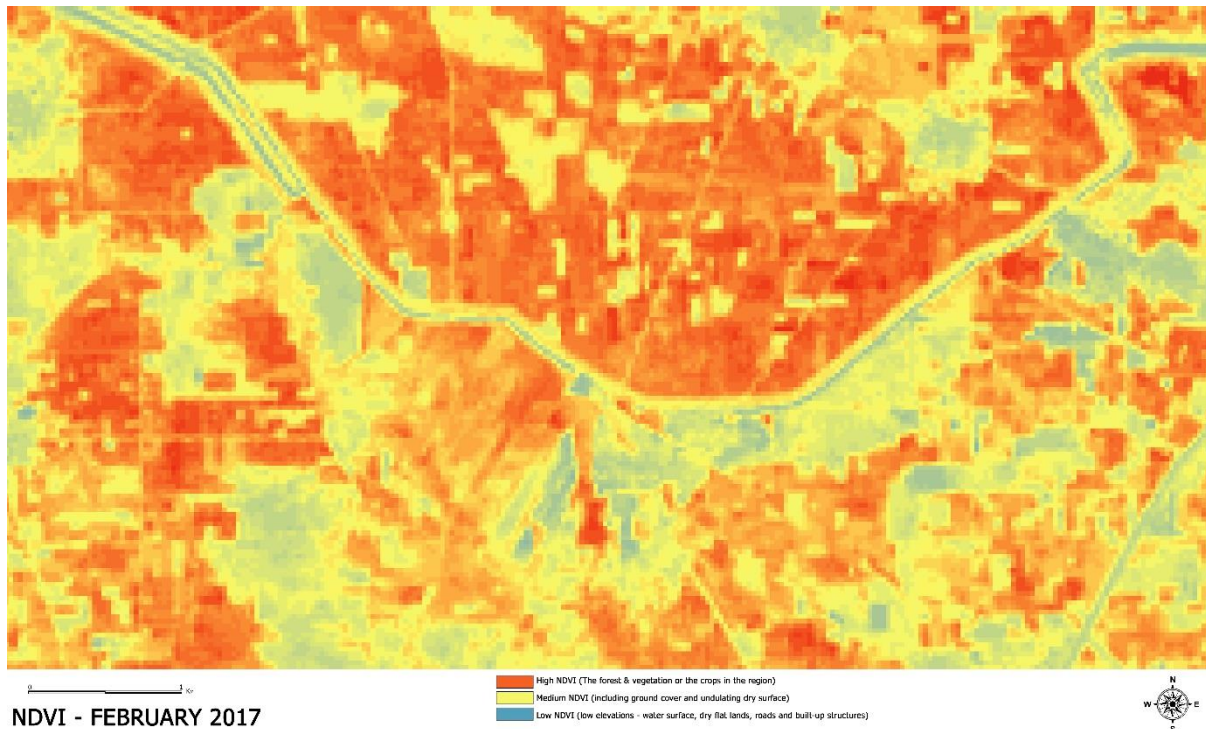


Figure 54: The NDVI map of February 2017.

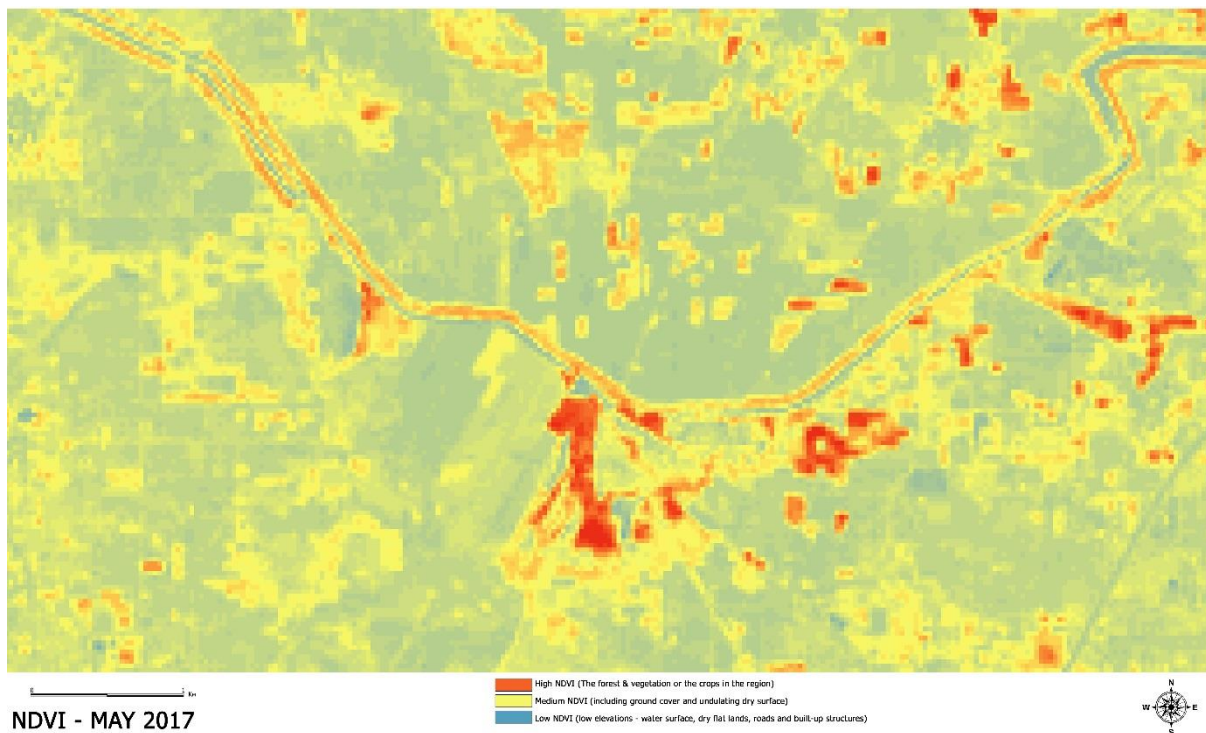


Figure 55: The NDVI map of May 2017.



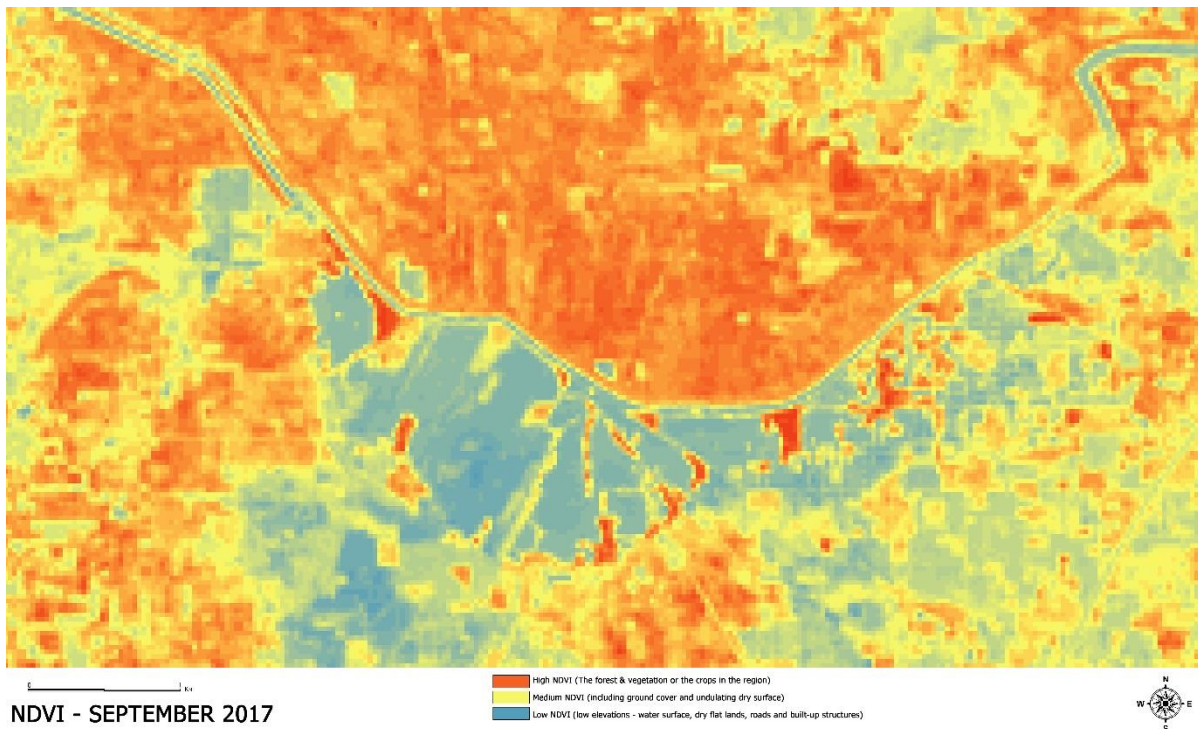


Figure 56: The NDVI map of September 2017.

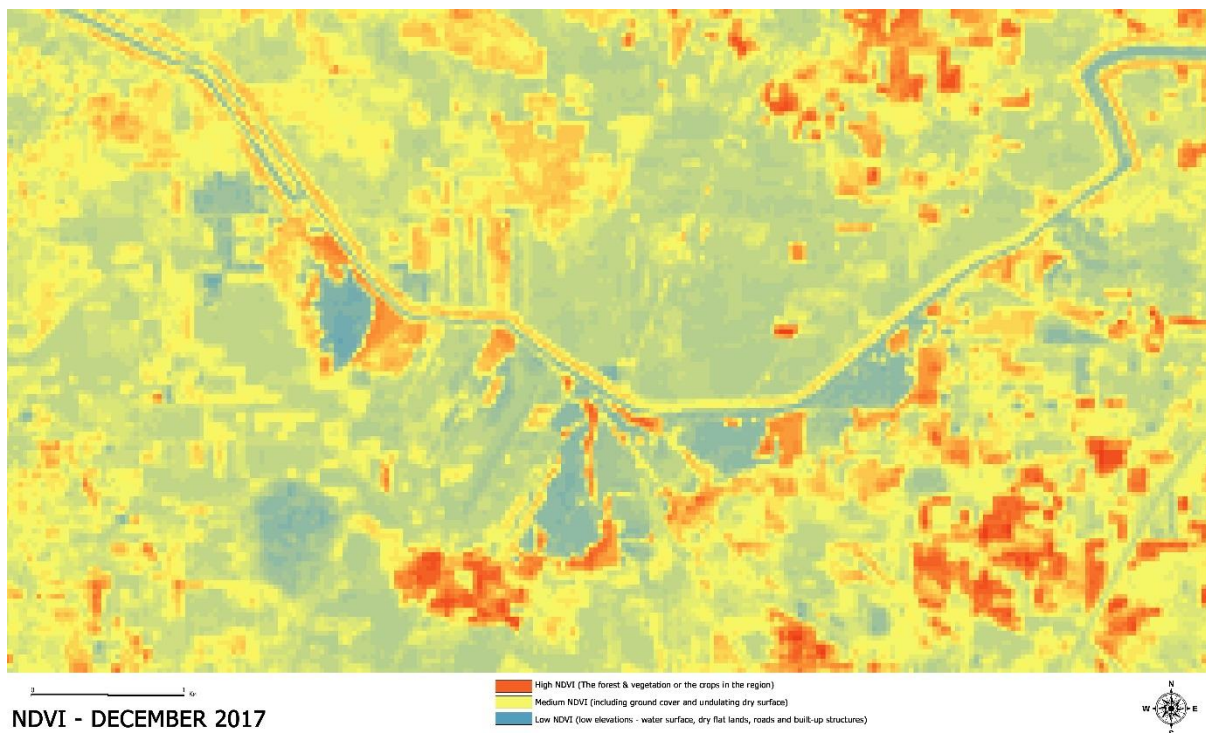


Figure 57: The NDVI map of December 2017.

The darker shade of blue color observed demarcates the presence of water in the area and can be clearly seen through these images the fluctuations in the levels of water throughout the year which demarcates the presence of a seasonal water body.



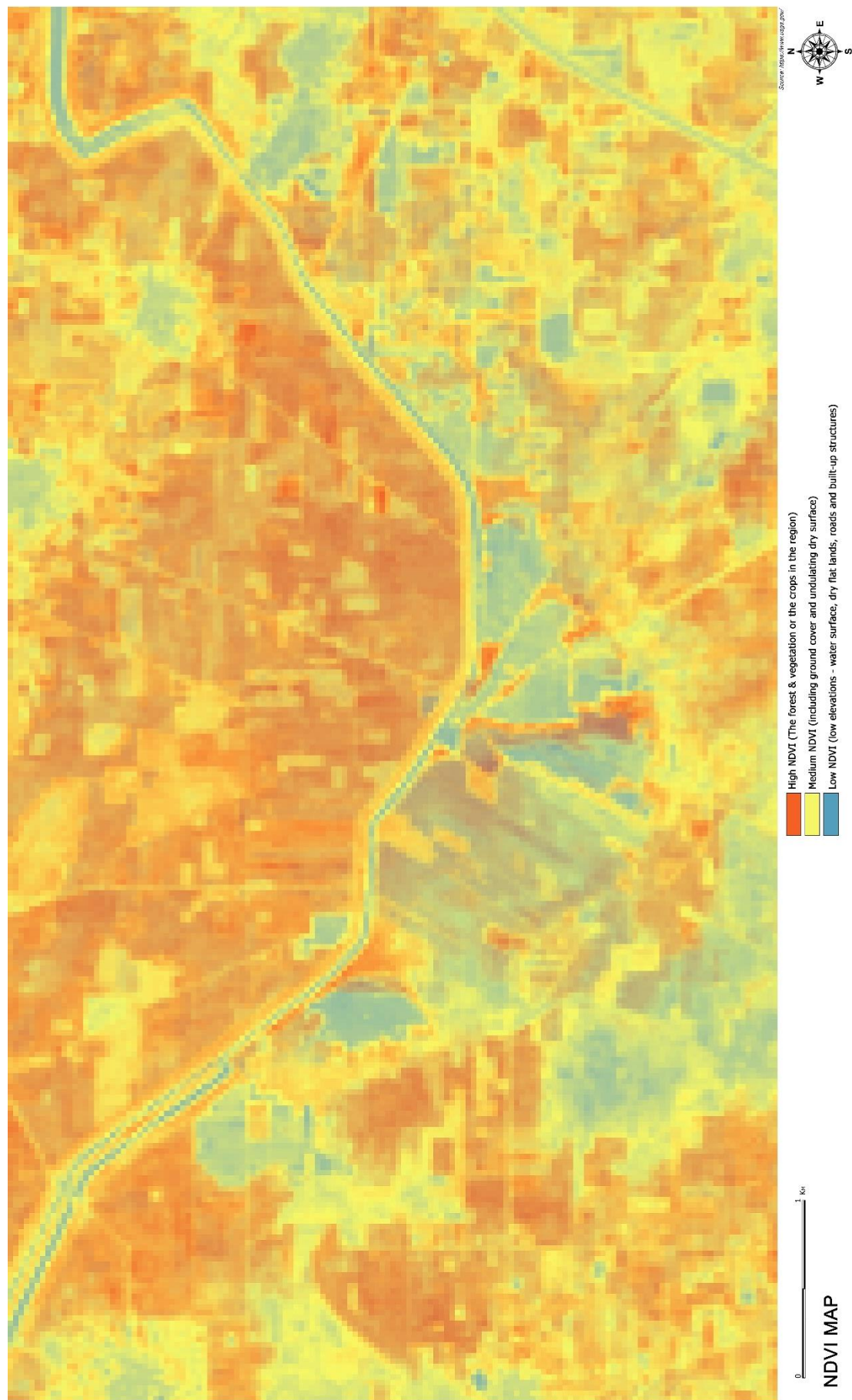


Figure 58: Overlapped NDVI Maps to show the variations.



## **7.3 Protected Areas & Eco Sensitive Zone in India.**

### **7.3.1 Protected Areas**

“A protected area is a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long term conservation of nature with associated ecosystem services and cultural values”. (IUCN, 2008)

Protected area favours the biodiversity conservation, they contribute to people’s livelihoods, particularly in the rural area. These areas are the mainstream of efforts towards preserving the nature and also providing the services like – food, clean water supply, and protection from the impacts of natural disasters etc. As per the estimation, protected areas globally stores at least 15% of terrestrial carbon and helps in mitigating the effects of climate change.

Protected areas create an important stock of natural, social and cultural capital, they yield economically valuable goods and services that help society, provide livelihoods, and contribute to attain many goals worldwide. Moreover, protected areas are key to buffering unpredictable impacts of impending climate change.

Protected areas are the initial steps of biodiversity conservation; they sustain key habitats, provide safe haven, allow migration and movement of species, and maintains the natural actions across the landscape. The protected areas conserve the biodiversity of an area whilst keeping an environment safe for human wellbeing.

The protected areas provide for the livelihood of nearly 1.1 billion humans and are also the main source of drinking water for different parts of the world’s largest cities. Better managed, connected, governed and financed protected areas are key to both mitigation and adaptation responses to the changing climate.



### 7.3.2 Eco Sensitive Zones (ESZs)

Those areas that are economically and ecologically important but are even sensitive to mild disturbances are known as ESZ and thus requires careful management. Therefore 'ecologically and economically important' areas are those areas that are biologically and ecologically 'rich', 'valuable' and or 'unique', and are largely irreplaceable if destroyed.

*“Further, by virtue of their biological richness, they could be potentially of high value to human societies, help in maintaining the ecological stability of the area, and be significant in conserving biological diversity. Similarly, their ‘uniqueness’ may be recognized either by the rarity of the living systems they harbour, that are difficult to replace if lost, or by the uniqueness of the services they offer to human society. Their ‘vulnerability’ could be determined by physiographic features that are prone to erosion or degradation under human and other influences such as erratic climate, and on the basis of historical experience.”* (Eco Sensitive Zones, n.d.)

The National Wildlife Action Plan (NWAP) 2002-2016 indicates that

*“Areas outside the protected area network are often vital ecological corridor links and must be protected to prevent isolation of fragments of biodiversity which will not survive in the long run. Land and water use policies will need to accept the imperative of strictly protecting ecologically fragile habitats and regulating use elsewhere”* (MOEF, The Environment ( Protection ) Rules, 1986)

*“All identified areas around protected areas and wildlife corridors to be declared as ecologically fragile under the environment (Protection) Act, 1986”* (MOEF, The Environment ( Protection ) Rules, 1986)

The National Board for Wildlife in March 2005 states that

*“The delineation of eco-sensitive zones would have to be site specific and relate to regulations, rather than prohibition, of specific activities”* (MOEF, The Environment ( Protection ) Rules, 1986)



### 7.3.3 Purpose of ESZs

The purpose of ESZs is straight forward, to demarcate zone of with that can go up to 10 km for the intention of conserving the core and the buffer zones of a protected area from external disturbances and maintenance of water and waste disposal to the zones, in terms of water runoff from the urban and rural built-up areas.

Some of the purposes of an ESZ as per ministry of Environment and forestry are; Maintenance of Habitat continuity through corridors or stepping stones, Regulation of other types of biodiversity friendly activities such as organic farming, Prevention of the inner zones from Air pollution, Water pollution and Noise pollution, Provision of biomass resources and renewable source of energy for livelihood need of people, and Provision of water for the livelihood needs of the people residing in the ESZ.

### 7.3.4 Extent of ESZs

*“The ESZs around Protected Areas will have to be kept flexible and Protected Area specific. The width of the ESZ and type of regulations will differ from protected area to protected area. In general the width of the ESZ could go upto 10 kms around a protected areas or beyond 10kms where sensitive corridors are present.” (MOEF, Wildlife Conservation Strategy, 2002 )*

The demarcation of the area of ESZ and the extent of regulation may not be uniform all around and it could be of variable width and extent.



### **7.3.5 Criteria for Demarcating ESZs**

Ecological significance or sensitivity of an area is broadly categorized into three important attributes:

**Biological attributes:** The demarcation of an ESA shall be considered on the basis of the following components:

1. Biodiversity richness
2. Species rarity
3. Habitat richness
4. Productivity
5. Estimate of ecological resilience
6. Cultural and historical significance

**Geo-climatic layers attributes:** These include attributes that permits the assessment of the natural vulnerability of the area.

1. Topographic features
2. Climatic features
3. Hazard vulnerability

**Stakeholders' valuation:** The opinions of the local bodies, especially the zilla, taluk or gram panchayats is very important in order to decide that the areas are considered ecologically and environmentally sensitive.





## 7.4 Eco Sensitive Zone Najafgarh Bird sanctuary

While discussing about the agricultural practices in and around the NBS, there will be certain guidelines that will enable the farmlands to avoid the general practices and go forth the traditional practices so as to preserve the biodiversity in the region. As per the geography and topographic constraints, the site when analysed as per the drainage situation of the area, the ESZ to conserve and protect the area up to 1.5 kilometres from the southern, south-eastern and south-western boundary and 250 meters from the northern boundary, and 100 meters from eastern and western boundary where the river enters and eventually exits the lake, respectively. Furthermore, the ESZs around the NBS, the Basai Wetlands and Sultanpur National Park can create corridors to provide a diversity in the region to increase the population of the birds and help them sustain. The ESZ will contain regulations related to agricultural practices and vegetation pattern and typology around the NBS, it will also constrain the illegal activities like poaching and hunting also will enable the protected areas to have a buffer from various pollutions like water air and noise. This zone will act as a shock absorber for the NBS and enable the biodiversity to thrive.

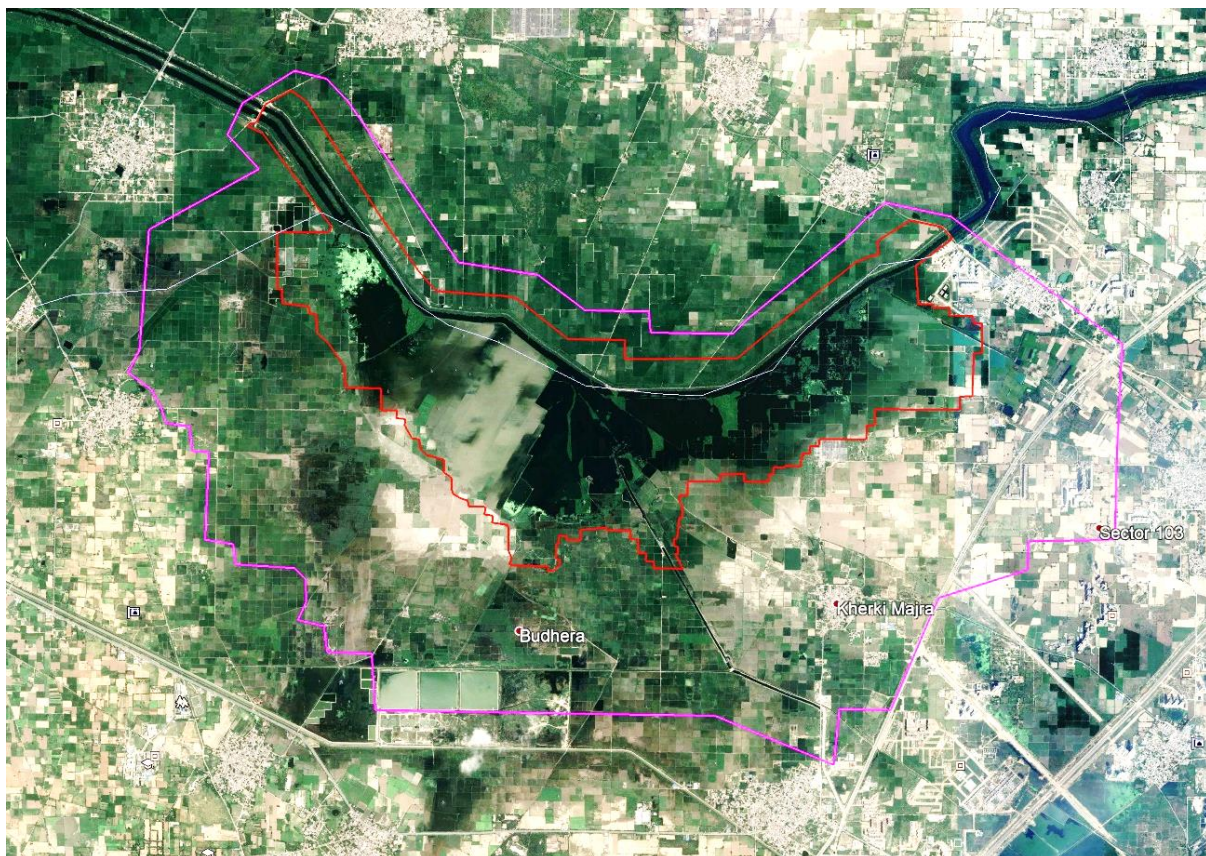


Figure 59: Figure showing proposal of ESZ boundary of Najafgarh Bird Sanctuary

Protected areas like Asola Bhatti Wildlife Sanctuary and Okhla Bird Sanctuary has defined ESZ boundaries declared by MOEF&CC.



Figure 60: Figure showing ESZ boundary of Okhla Bird Sanctuary defined by MOEF&CC

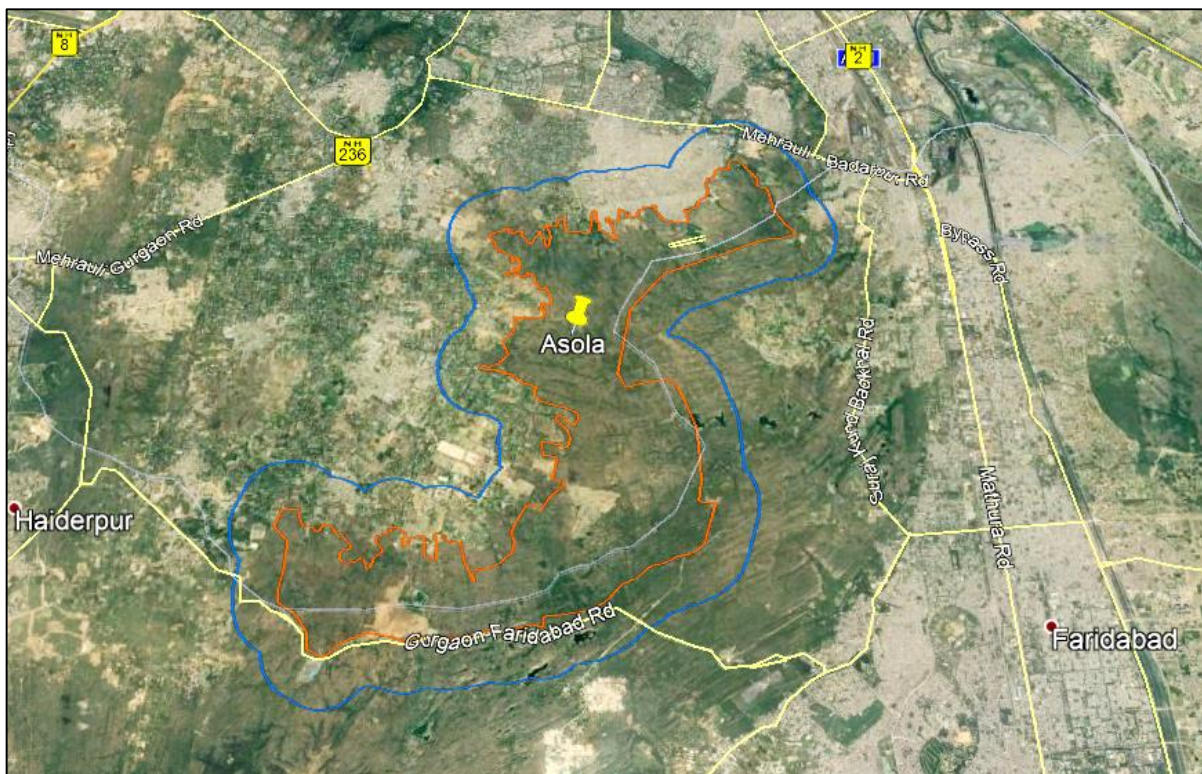


Figure 61: Figure showing ESZ boundary of Asola Bhatti Wildlife Sanctuary defined by MOEF&CC



## **7.6 Sustainable Agricultural Practices**

The Landuse and Landcover map of Delhi and gurugram demarcates the NBS and the surrounding areas as agricultural lands. Some part of the ESZ in gurugram comes under Urbanisable Land, the current scenario of the area is purely agriculture leaving the eastern side which is currently seeing a residential development.

The ESZ terms state the regulation of the practices rather than prohibition so the agricultural lands will go for a sustainable agricultural practices which includes technical support and training to local farmers, this enable them to not only improve their livelihood but also help them protect their land and communities.

From water managements to soil conservation and preservation; from energy management to social and community developments.

## **7.7 Water Management**

The area under the NBS is flooded during the monsoon and the early winter months and thus prevents Kharif crops hence the farmlands in the area are used for the Rabi crops. Wheat is grown in abundance in this area and this practice is followed by introduction of pesticides and various chemicals to get high yield.

Using effective traditions methods will help in controlling and use of organic manure will give promising results and help prevent the pollution level in the lake to sustain the biodiversity.

Total quantity of water required during operation of the NBS will depend on the number of population visiting the sanctuary, staff required for different purposes and for Gardening purposes. Fresh water required for drinking or kitchen purposes should be sourced by Delhi Jal Board and rest of the water requirement should be fulfilled by STP treated water from nearby STP.

Waste water generated from the sanctuary should not be directly discharged into sewer without its treatment. The waste generated should be sent to nearby STP for its treatment.



## **7.8 Air Pollution Control & Management**

No vehicular movement should be allowed inside the premises. Only battery-operated cars should be allowed for the convenience of the people visiting the sanctuary. Moreover, there shall be designated spaces provided for the parking of vehicles.

Solar Panels should be installed at the roof of the building in order to maintain the U and R value of building envelope and also harvests the solar energy which can be used in place of electricity during emergency purposes so that no requirement of DG sets are there inside the premises.

Solar lights and solar hot water panels should be installed inside the sanctuary.

## **7.9 Soil Conservation & Preservation**

The area surrounding the NBS will go forth the agricultural practices where crop rotation of season changes in crop pattern is proposed to improve the prevent soil from degradation and prevent from overuse of the land to become a wasteland.

## **7.10 Noise Control & Management**

Increased noise levels due to the growth in transportation networks and urban areas are spreading into entire ecosystem. As Delhi and Gurugram areas are very crowded thus, human caused noise can have detrimental consequences for fauna of the Najafgarh Bird Sanctuary. Thus, it is very important to manage the noise in urban areas in order to maintain a peaceful and calm atmosphere. To tackle this certain rules must be followed always like Noise barriers should be installed to reduce traffic noise & vibrations.

Planting of the trees also known as green belt at the boundary of the complex will reduce the level of the outside noise. Thick vegetation should be maintained as green belt. No vehicular movement should be allowed inside the sanctuary. Signs of No honking should be maintained in the nearby areas.



## **7.11 Planting Strategy**

Policies and guidelines related to the regulation of the various habitats and the pattern of vegetation in those habitats, are to be framed so that the practice of conservation of the biodiversity and the wetland ecosystem follows the regulated terms when it comes to the maintenance and protection of the sanctuary.

The replacing of the existing vegetation with that of bird's friendly vegetation to be welcomed.

Plantation in the project area helps in arresting not only the particulate matter but will also attenuate the noise & air pollution to a great extent and will contribute positively to the environment. The trees also help in maintaining the regional ecological balance and hydrological conditions. Moreover, plantation of more trees attracts more birds to the area and provide them a natural habitat. Preference should be given to Indigenous species.

Green belt/greenery shall be developed along most of the periphery of the project area as well as along roads.

### **Some Benefits of planting trees:**

- 1) It provides wind protection for crops in rural areas.
- 2) Also controls soil erosion.
- 3) It creates diverse plant and animal habitats.
- 4) It purifies the air absorbing carbon monoxide, sulphur dioxide and nitrogen dioxide.
- 5) Trees muffle urban noise.
- 6) A mature leafy tree produces as much oxygen in a season as 10 people inhale in a year.
- 7) Trees helps in cleansing the air.

Policies and guidelines related to the regulation of the various habitats and the pattern of vegetation in those habitats, are to be framed so that the practice of conservation of the biodiversity and the wetland ecosystem follows the regulated terms when it comes to the maintenance and protection of the sanctuary.



### **7.11.1 Buffer Planting**

A buffer of native trees and shrubs that sustain the birds are to be introduced so as to cater the ever increasing population of the birds. The buffering will be triple layer, the external layer has to be tall but dense trees to provide a layer to protect from external disturbances be it for controlling the wind speed or protection from noise pollution. The second layer will be small trees or tall shrubs to provide a roosting area for the birds of edge species and various other visitors. Now the layer near the water edge will be of drooping or falling trees and shrubs underlined with hydrophilic ground cover and then a zone of aquatic plants. This triple layer solution is ideal for any bird sanctuary with a nearby urban establishment as it provides a dense hideout visible from outside but is a safe haven, a sanctuary for the birds inside.

### **7.11.2 Wetland edges**

The wetland edges are very areas when it comes to restoration of a wetland, the edge has to be catered to the existing water conditions and change in vegetation has to be in such a way that it does not disturbs the edge, the edge plantation will have hydrophilic shrubs & groundcover and entering the water is a zone of aquatic plants which help increase the oxygen level in the water to cater the BOD of the water.

### **7.11.3 Plants inside the sanctuary**

#### **The wetland and trails**

The trees near the wetlands and the trails will be in such a way that they provide food in abundance so as to cater the winter birds when they arrive the site to feed and roost as well as cater the need to provide privacy and nesting areas for them.

Presently single typology is seen throughout the site and to break this monotony a planting scheme to provide diversity with the replacing of existing trees with native fruit bearing and flowering trees.



## **The recreational areas**

The trees in the recreational zone will be to attract the birds from the core zone just for the purpose of having their own recreational areas with more involvement with the human population, a planting scheme of more of native flowering trees and also shelter providing trees is followed.

### **7.11.4 Farmlands**

To provide some of the existing farmlands work in a regulated way in the park as well as in the surround ESZ the planting scheme provided will cater to boom a new type of local economy, promotion of Floriculture and farming of fruit bearing trees and promotion of organic agriculture practices related to the cultivation of wheat in the areas is seen as a perfect solution.

The edge planting scheme in the farmlands is provided, where shade providing trees and trees with dense canopy are to be planted to provide shelter to birds as well as shade to the crops and humans alike.

## **7.12 Area Demarcation for Recreational Activities**

The recreational activities should be away from the conservation area as this area is prone to vehicular activities and increased human activities from and these disturbances will be harmful for the biodiversity.

The area for recreational zone is proposed to be on the northern side of th

Since, it is a Bird Sanctuary thus, no human intervention will be allowed in the core zone. However, in the buffer zone following activities are proposed:

- Tourism Management Station
- Museum
- Gallery
- Open Air Theatre
- Visitor's Centre
- Offices
- Cafeteria
- Staff Quarters
- Guest House
- Toilets
- CCTV Surveillance
- Designated Parking Areas
- Interpretation Centres





## Bibliography

- GUIDELINES FOR DECLARATION OF ECO-SENSITIVE ZONES AROUND NATIONAL PARKS AND WILDLIFE SANCTUARIES, MOEF (Wildlife Division), Govt. Of India
- NOTIFICATION OF ECO SENSITIVE ZONES (ESZ) AROUND PROTECTED AREAS (NATIONAL PARKS & WILDLIFE SANCTUARIES IN THE COUNTRY, MOEF, Govt. Of India
- CONSTITUTIONAL PROVISIONS FOR PROTECTION OF ENVIRONMENT, Govt.Of India
- AGRICULTURE AND RURAL DEVELOPMENT, Chapter 10, Economic Survey of Delhi 2012-2013, Govt. Of Delhi-NCT
- National Mission for Sustainable Agriculture (NMSA)(2014), DAC and ICAR, Ministry of Agriculture,Govt. of India
- Macfarlane, D.M., Bredin, I.P., Adams, J.B., Zungu, M.M., Bate, G.C. and Dickens, C.W.S. 2014. *Preliminary guideline for the determination of buffer zones for rivers, wetlands and estuaries. Final Consolidated Report.* WRC Report No TT 610/14, Water Research Commission, Pretoria.
- Cadenasso, M.L., Pickett, S.T.A., Weathers, K.C., and Jones, C.G. 2003. A framework for a theory of ecological boundaries. *Bio Science.*
- Department of Environment and Resource Management, 2010. Queensland wetland definitions guideline: a guide to existing wetland definitions and the application of the
- Queensland wetlands program definition. Queensland.
- Department of Water Affairs and Forestry, 2000. A practical field procedure for identification and delineation of wetlands and riparian areas. Republic of South Africa.
- Dewey, J.C., Schoenholtz, S.H., Shepard, J.P., and Messina, M.G. 2006. Issues related to wetland delineation of a Texas, Usa Bottomland Hardwood Forest. *Wetlands.*



## 8 PROPOSAL: NAJAFGARH BIRD SANCTUARY

The proposal of the wetland with respect to the biodiversity and the wetland ecosystem of the large shallow water body will cater three major parameters. Furthermore the policies and guidelines denoted to the protected area with respect to the surroundings and also keeping in mind the Eco-Sensitive Zone around the site are provided in this chapter.

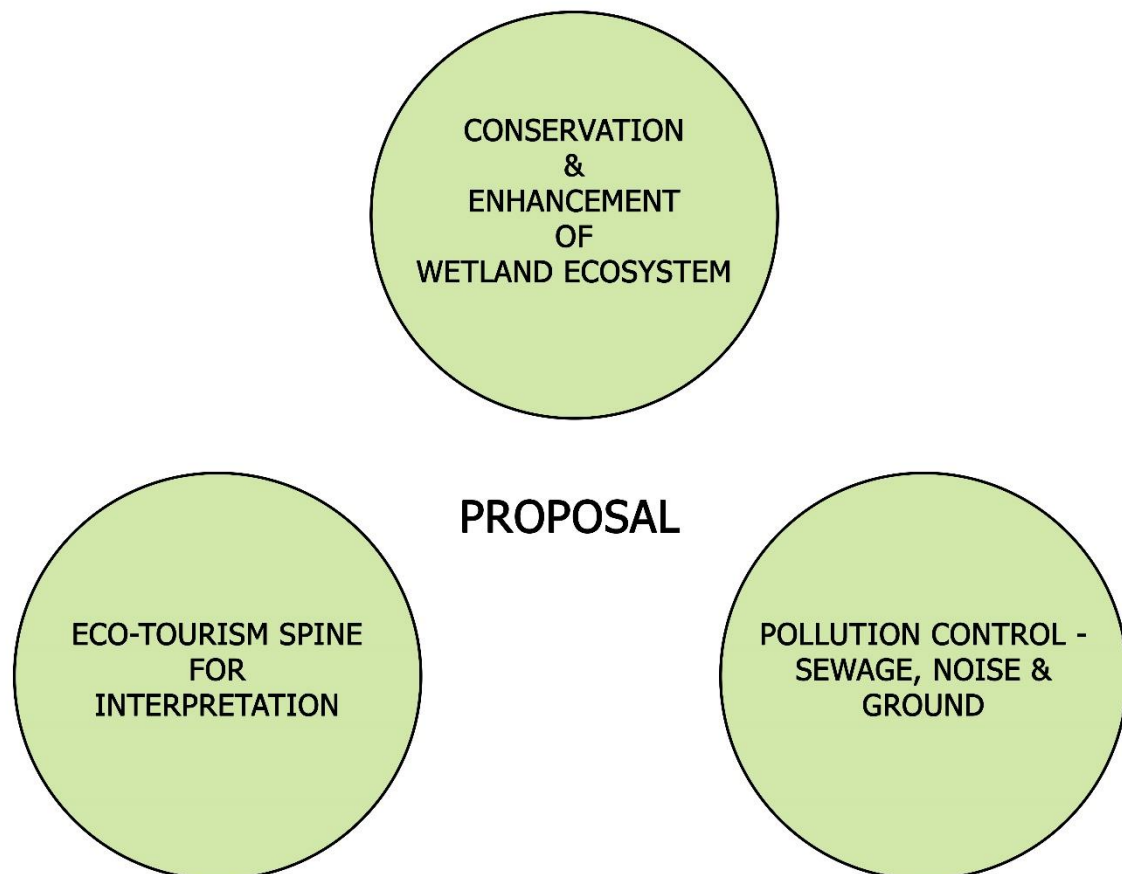


Figure 62: Proposal Strategy for Najafgarh Bird Sanctuary.

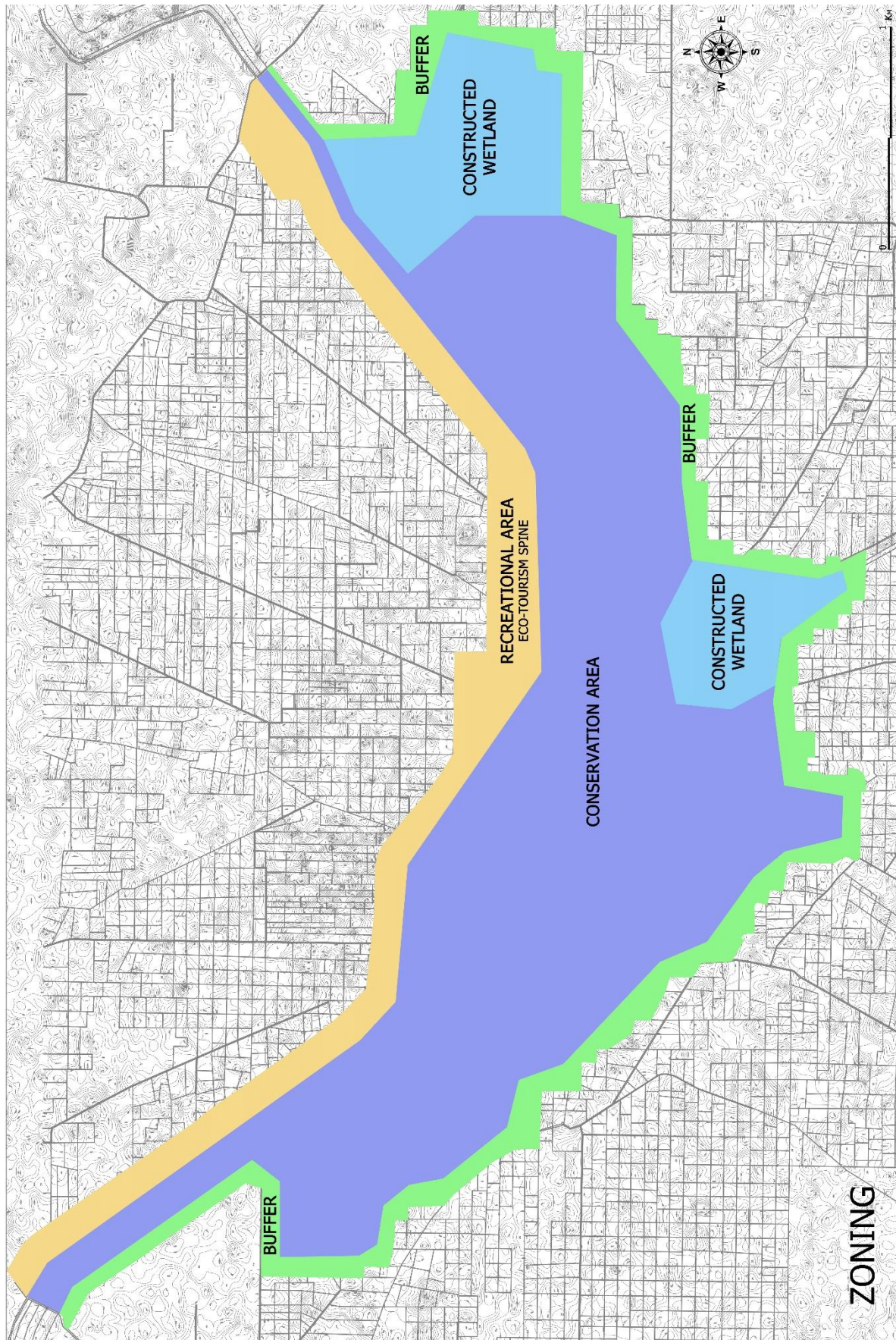


Figure 63: Proposed Zoning.



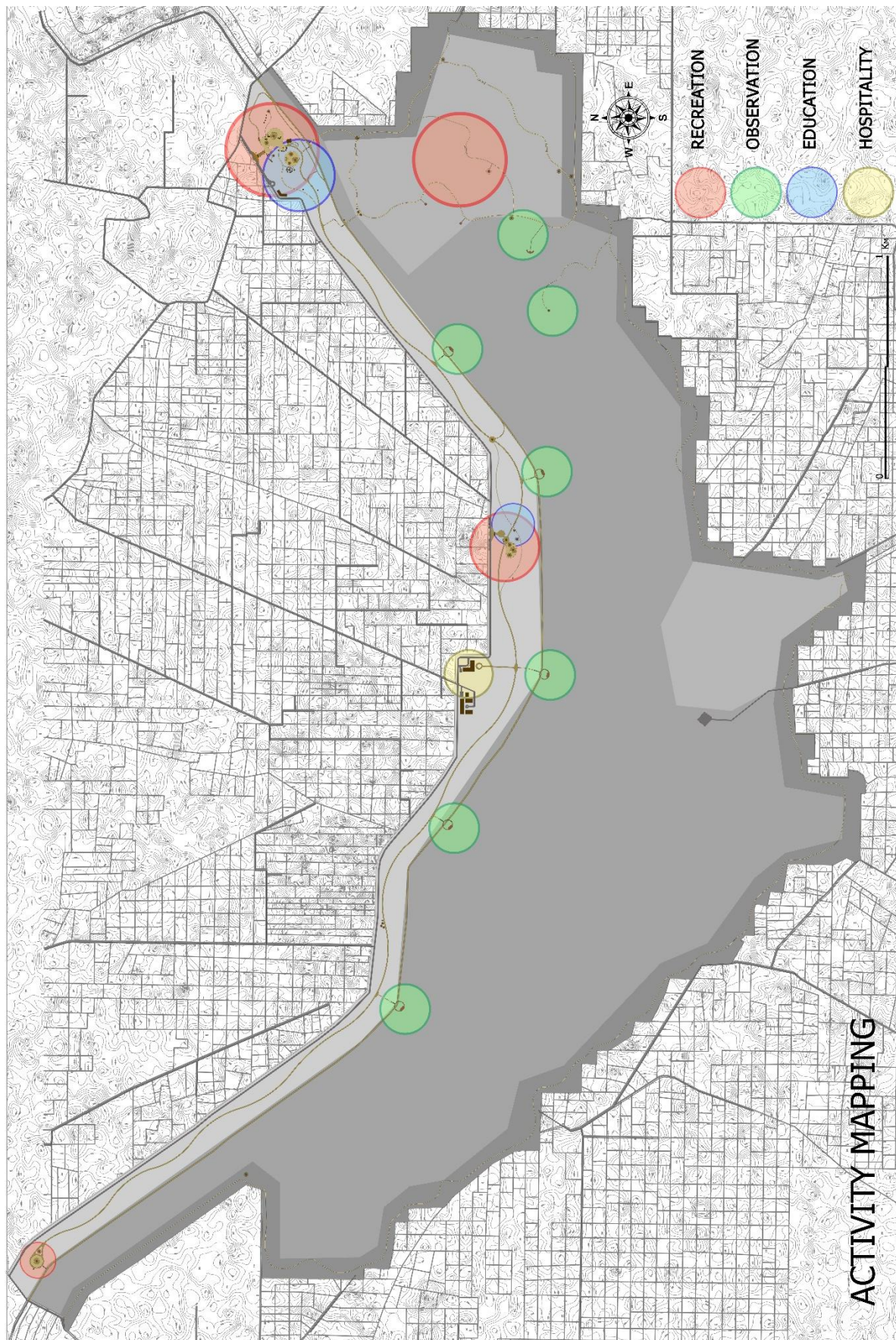


Figure 64: Proposed Activity Mapping.

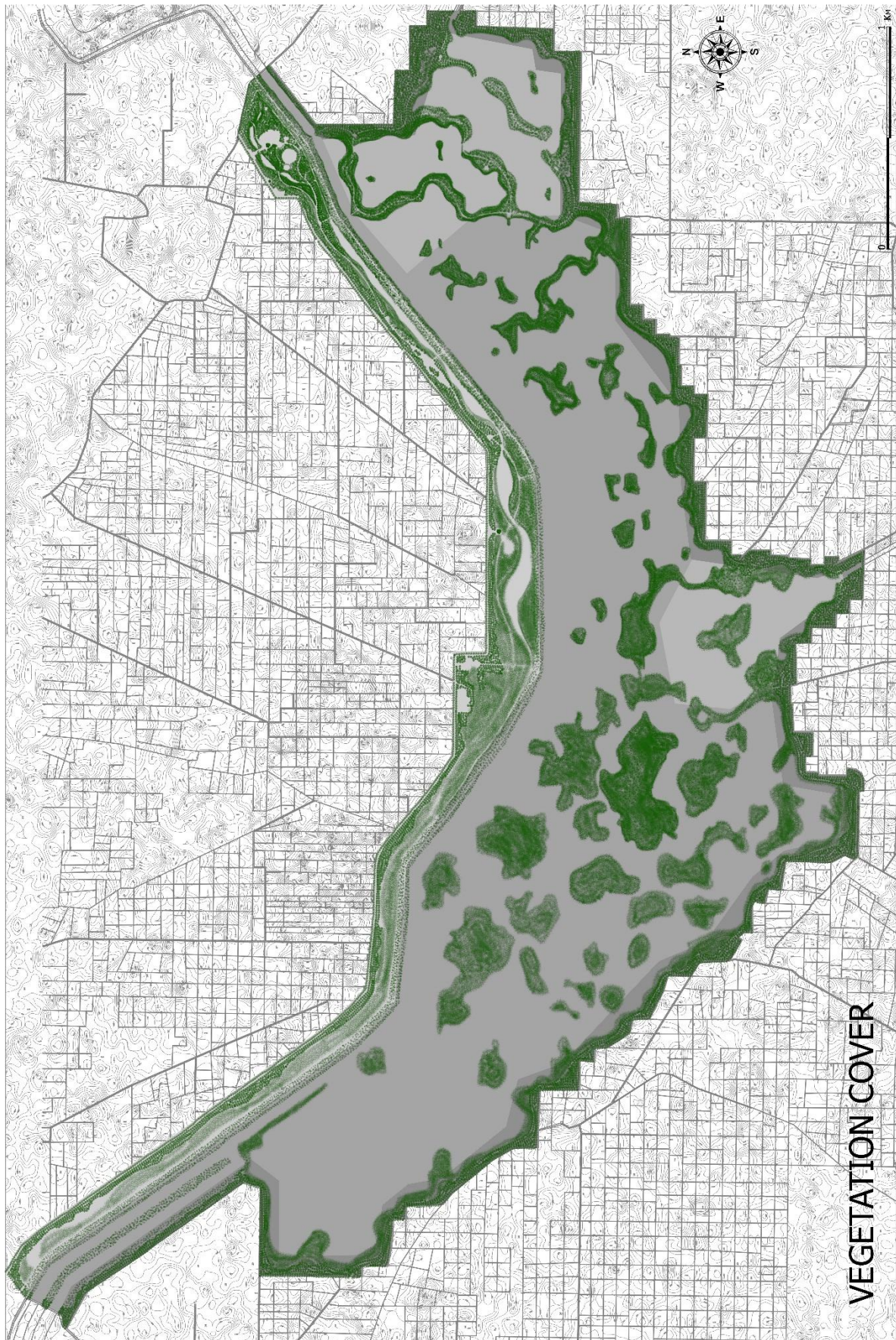


Figure 65: Vegetation Cover.



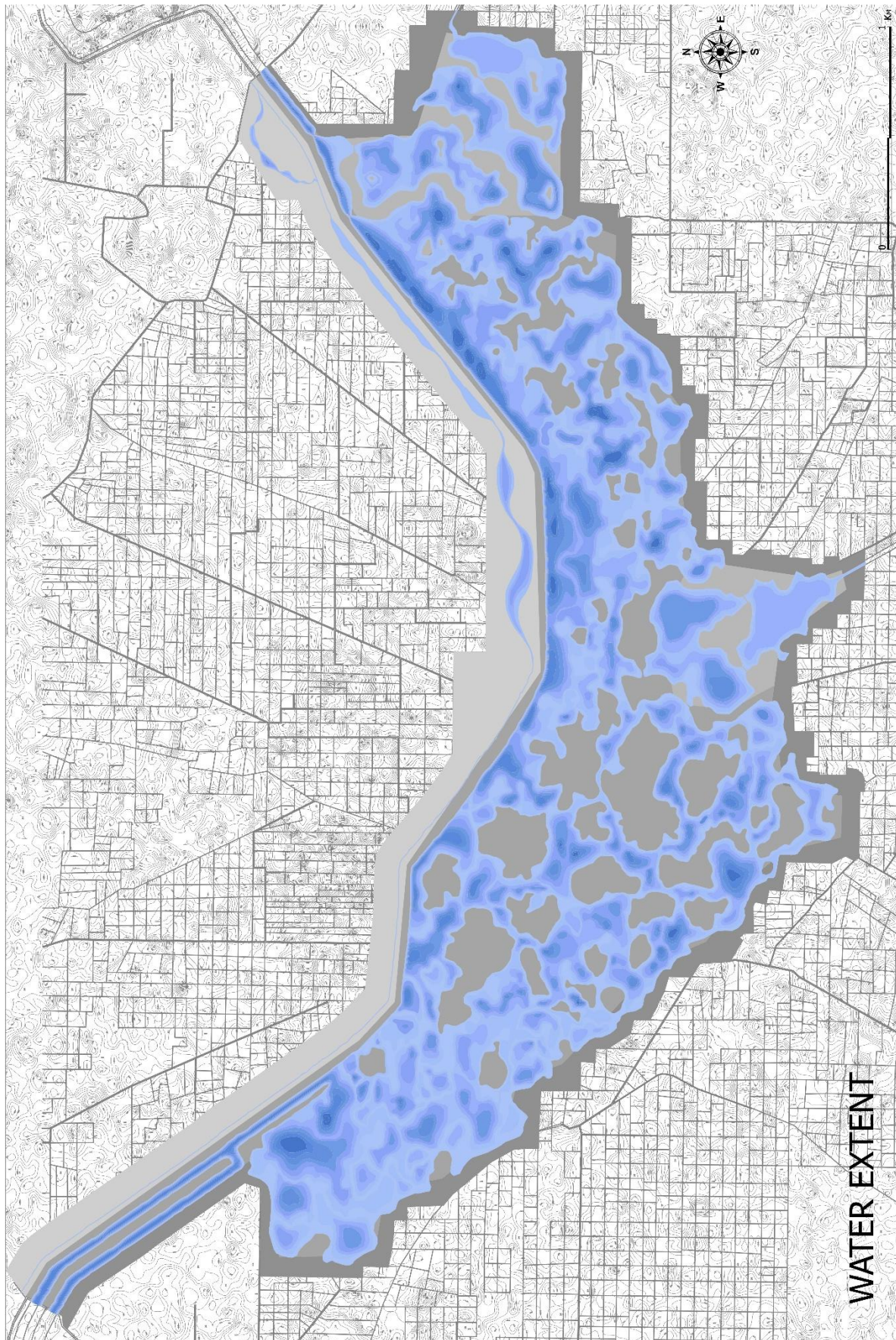


Figure 66: Water Extent.



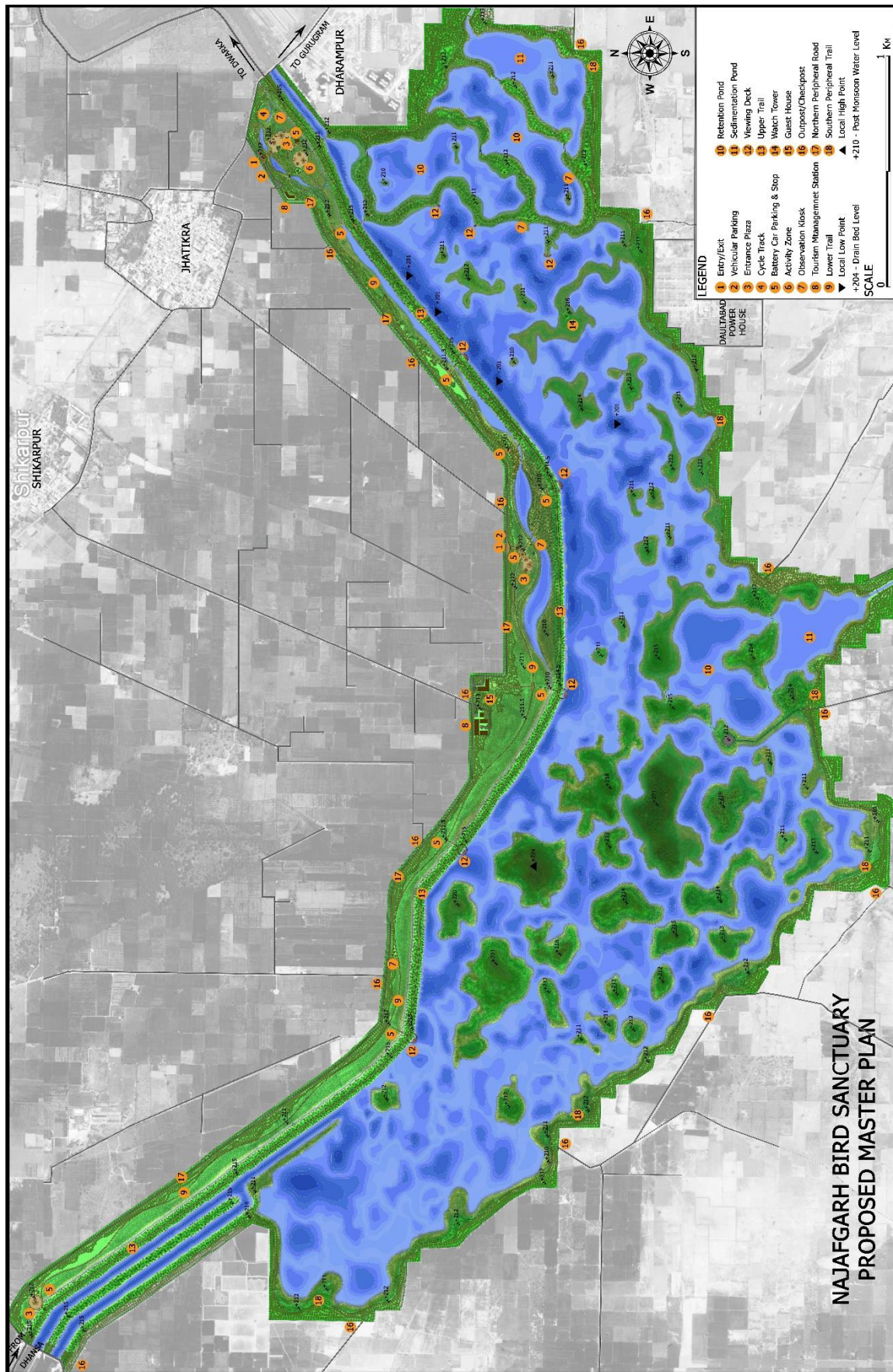


Figure 67: Proposed Master Plan of Najafgarh Bird Sanctuary.





Figure 68: Sections of Proposed Master Plan of Najafgarh Bird Sanctuary.







Figure 69: Sections of Proposed Master Plan of Najafgarh Bird Sanctuary.



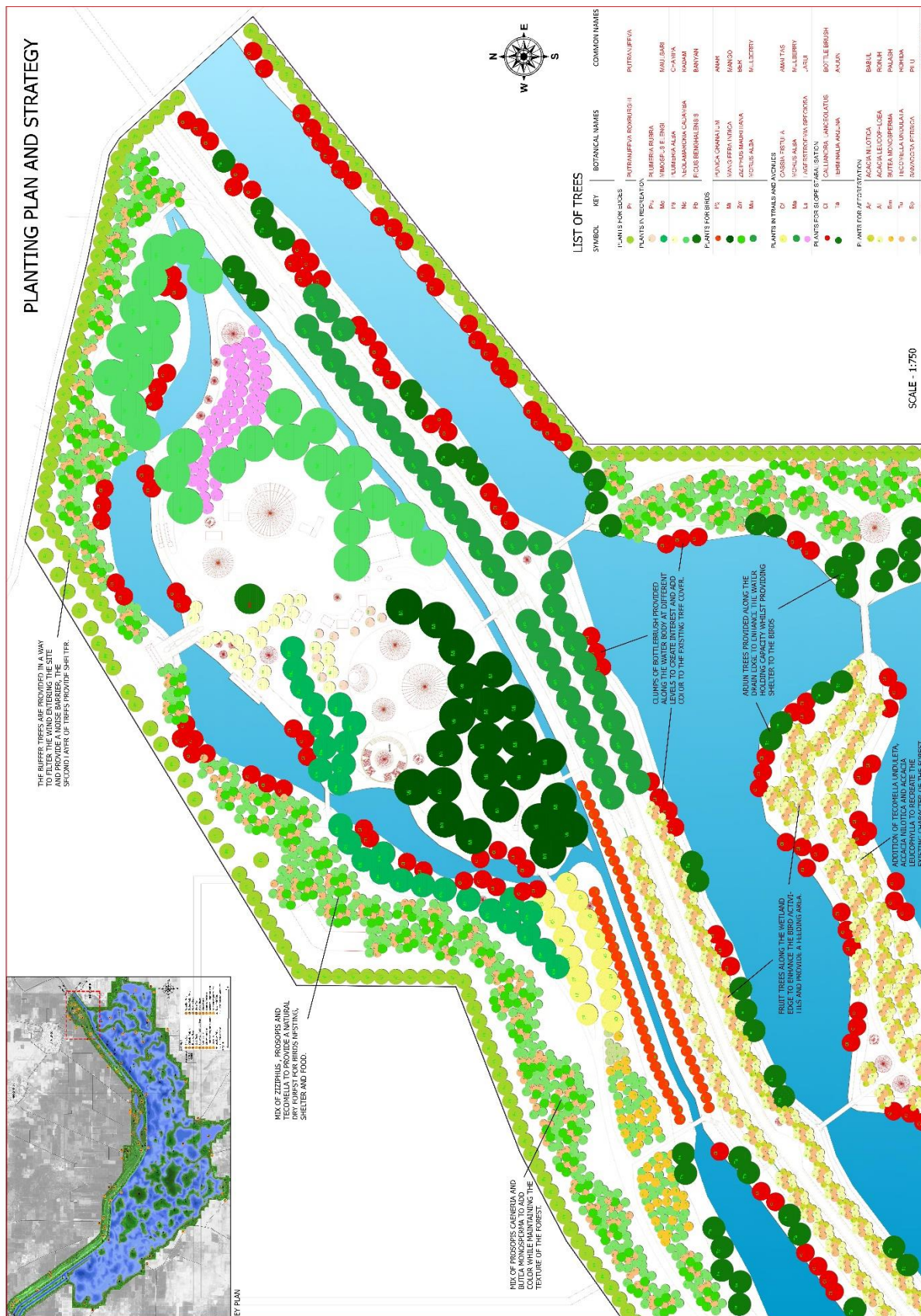


Figure 70: Proposed Planting strategy to be followed throughout the site.



## **9 CONCLUSION**

A new bird sanctuary in the national capital region can conserve the critical wetland habitat and make people sensible and aware towards nature and many other factors related to sensitive ecosystems and the harm that are caused by human activities can come to light.

This thesis proposal aims at maintaining an ecological balance between man and nature, and buffer zones provide a healthy transition between the two.

In this world of ever growing human activities, the bird sanctuary play a major role in maintaining the ecological balance of wetland ecosystem. The eco-tourism proposal is aimed to control tourism in sustainable manner.

The najafgarh jheel which is now home to many migratory bird species is also just a remainder of a large patch of a lake turned to wetland which is in ever growing danger of being complete turned into a farmland.

This project can create awareness and conserve critical habitat of wetland ecosystem.

Landscape architects always find new ways to discretely help nature and help create balance and have the ability to plan for ecological and social resilience. It is our duty to ensure that a healthy man-nature relation is maintained, via this project I aim at a very crucial central nerve in this relation where how in our nature we treat our guests,

“Atithi devo bhavah”

A motto which simply translates our guest are to be treated like gods, and so it is true that in Indian culture we treat our guest like they are an epitome of god, so why leave any guest at harm, lets welcome these wonderful guests the way they are supposed to be treated, not by hunting, not by encroaching their stay place but by building a new and a better world for them and for ourselves.

