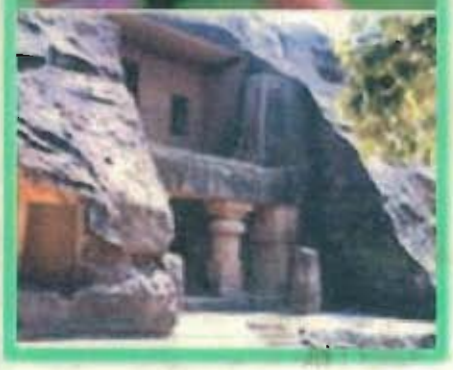

FINAL REPORT

ENVIRONMENTAL MANAGEMENT PLAN FOR SANJAY GANDHI NATIONAL PARK, Borivali

(A Project sponsored by MMR-Environment Improvement Society, Govt. of Maharashtra)

Prepared by:

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MAY 2002

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Sushant Agarwal

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CHAPTER 1 PREAMBLE

1.1 INTRODUCTION

Sanjay Gandhi National Park (SGNP), occupying an area of 103.09 sq. km, lies partly in Thane District and partly in Mumbai Suburban District. The park is one of the very few in the world that is surrounded by a metropolis like Mumbai, yet sustaining a large variety of flora and fauna including several endangered species.

With a view of initiating a systematic environmental management strategy in the park, a project entitled "Environmental Management Plan for SGNP" was proposed by Sushant Agarwal of Serene Environmental Services to MMR-Environment Improvement Society, for sponsorship. After extensive review by MMRDA, the project was awarded in December 1999.

The study was a year long exercise in which first hand environmental baseline data was monitored and analysed for several components such as surface and groundwater quality, lake water and its catchment, vegetation, landuse pattern, air quality and noise etc. Activities and issues in park and its surrounding that could exert a negative impact on the park ecosystem and existing management practices for handling these issues were also studied in detail for all ranges in the park. An environmental management plan was then developed based on the findings of the study.

The study methodology included extensive site visits, interviews with forest officials and review of technical literature. The study was conducted with the help of a project team comprising of professionals from various disciplines. The following key professionals were involved with the study. This team was assisted by chemists, botanists and analytical laboratories.

Name	Organisation	Major Function/Role
Sushant Agarwal *M.S. (Environmental Engeering) – USA*	Serene Environmental Services, Mumbai	Team Leader. Overall planning of the study. Data analysis and interpretation
Dr. S.B. Chaphekar *Ph.D Botany*	Leading Botanist and Ecologist	Flora and forestry studies and other ecological studies. Guidance in study methodology and data analysis.
Gouri Deshmukh *M.Sc. – Environment*	Serene Environmental Services	Aquatic Ecosystems, Lake bio-assessment and other ecological studies
Swapnil Sheth *M.Sc. - Environment*	Serene Environmental Services	Data compilation and analysis
Dr. Kranti Yardi *Ph.D - Zoology*	Zoologist	Biological assessment of lakes

The study has been carried out in the right spirit and earnest with an aim to provide a structure for long term environmental management for SGNP. In conducting this assessment all work was performed in a manner consistent with the level of care and skill ordinarily exercised by members of the profession currently practicing in under similar conditions.

1.2 ENVIRONMENTAL MANAGEMENT PLAN REPORT

This report consists of the findings of baseline environmental study for various ecosystems in SGNP and a detailed description of the environmental problems in the park and current management practices. An Environmental Management Plan for mitigating impacts of various detrimental activities in the park was prepared and is presented here.

It is expected that this report should be kept dynamic in nature and should be updated to reflect changes in current situation by SGNP at-least on an annual basis.

This report consists of total 7 chapters. Important tables, figures and related photographs are given in the Annexes. The following are the Chapter details:

Chapter 1 - Preamble
This chapter gives brief background of the project and report format.

Chapter 2 – Executive Summary

Chapter 3 – Park Description
This chapter describes SGNP location details, brief history, geology & soil, topography, prominent features of the Park and attractions of the park etc.

Chapter 4 – Baseline Environmental Quality in SGNP
This chapter is divided into 6 sections and each section is dedicated to a specific environmental component.

- Section 1 – Introduction
- Section 2 – Air Environment
- Section 3 – Noise
- Section 4 – Aquatic Environment
- Section 5 – Terrestrial Ecosystem
- Section 6 - Landuse Study

Chapter 5 – Legal Aspects and Administrative Framework
This chapter deals with the legal and administrative framework for park administration.

Chapter 6 – Significant Environmental Issues in SGNP

This chapter describes activities / issues in SGNP, which could significantly impact the environment and also describes related existing management practices for such issues.

Chapter 7 – Environmental Management Plan for SGNP

This chapter highlights the environmental problems in the SGNP area and provides action plans for managing such issues.

CHAPTER 2 EXECUTIVE SUMMARY

2.1 INTRODUCTION

Sanjay Gandhi National Park (SGNP) is a small part of Mumbai City, yet this tiny place on the face of our planet is a masterwork of the natural world. Mumbai is one of the few cities in the world to have such an immense expanse of greenery within its municipal limits. SGNP is of incalculable value to those who seek it. This green oasis, with its rich biodiversity, its picturesque landscape, its lakes and streams, acts as a respite to the twelve million inhabitants of this concrete jungle from the drudgery of a hectic yet monotonous existence.

The project "Environmental Management Plan for SGNP" was proposed by Sushant Agarwal of Serene Environmental Services to MMR-Environment Improvement Society, for sponsorship. After extensive review by the Society, the project was awarded in December 1999. The project work was initiated on January 28, 2000. Site reconnaissance was done along with project team on January 28, 2000. Based on the findings of the visit, an Inception Report was presented to MMRDA and Dy. Conservator of Forests, SGNP.

2.2 SCOPE OF THIS REPORT

The scope of the study was as per the terms of reference in the proposal and agreement between MMR-Environmental Improvement Society and Sushant Agarwal. The entire study includes the following major components:

a. Monitoring baseline environmental status for all 3 seasons i.e. winter, summer and post-monsoon. An interim report for winter and summer season baseline environmental data was submitted to the Society in August, 2000. The baseline monitoring study included the following parameters:
   - Landuse mapping of SGNP and water bodies such as Tulsi Lake, Vehar Lake and Powai Lake, using satellite imagery techniques.
   - Ambient Air Quality
   - Ground and surface water quality
   - Biological assessment of the lakes
   - Vegetation study and soil charaterisation at select park areas.

b. Identification and study of all activities in park and its surrounding that could exert a negative impact on the park ecosystem. Quantification of such disturbances where practicable. Study of existing management practices for handling these issues.

c. To develop an Environmental Management Plan (EMP) for control and minimization of adverse impacts identified and for various other issues in the park having environmental significance.

2.3 MAJOR FINDINGS AND CONCLUSIONS

2.3.1 Baseline Environmental Status

Air and Noise Quality

- On the whole all parameters such as SPM, RPM, NO_X, SO_2, HC and CO were within the standards of ambient air quality for sensitive area. However, some 24-hr average readings of SPM and RPM levels were found to be higher than the standards at the SGNP gate at Borivali and at Yeur Village. This is mainly due to the proximity to heavy traffic on western express highway and traffic in Yeur village respectively.
- Noise levels in SGNP area varied between 30 to 65 dB (A). Nighttime exceedances were observed mainly at Yeur Village. These noise level exceedances can be attributed mainly to vehicular noise.

Surface and Ground Water

- Groundwater quality at all locations were within the drinking water standards (IS 10500) for all important chemical parameters. However at locations such as Gautam Nagar, Mafco factory, Bambuhut and Tumnipada microbial count was higher than limits. At these places water must be treated prior to use as drinking water.
- In case of other surface water streams such as Dahisar and Chenna river, chemical parameters were well within the IS limits, but water is not potable without treatment as it has high coliform counts.
- In Bassein creek most of the parameters were found exceeding the limits. Dissolved Oxygen was recorded as 3 mg/lit, which is not sufficient for sustaining aquatic life.

Lake Ecosystem

- Plankton analysis indicated β meso-oligosaprobic, β meso-oligosaprobic, β mesosaprobic state of Tulsi, Vihar and Powai lakes respectively. This indicates that the pollution load in Tulsi and Vihar was comparatively much lesser than Powai.
- When all three lakes were compared, DO levels were recorded to be lowest in Powai lake. Powai lake was also found to have the highest productivity indicating higher pollution levels.
- Tulsi lake catchment and shoreline was the best among the 3 lakes. The shoreline of Tulsi and Vihar lakes had a variety of macro-invertibrates and lake water had very few macrophytes. In comparison, Powai Lake had large amount of water hyacinths due to nutrient discharge into the lake.
- Tulsi lake water was found to be of very good quality. Vihar lake water had microbial contamination at several locations where human trespassing and usage of lake water for domestic purposes such as washing, bathing etc. is common. Powai Lake water is of poor quality, turbid, greenish color due to large number of phytoplankton.

Higher BOD and COD values indicate contamination by organic matter. High MPN values were observed in all samples.

- Bottom sediments from Tulsi and Vihar lake indicated no significant levels of heavy metals. Heavy metals levels in Powai lake sediments were observed to be higher than these two lakes.
- No riparian vegetation was seen in any of the three lakes.

Terrestrial Ecosystem

- Tulsi forest (core zone) is an ideal mixed moist deciduous forest. Whereas, Vihar catchment and Sasunavghar forest (Buffer Zone) are slightly degraded but shows much similarity with Tulsi Forest. However, presence of *Ficus hispida*, a secondary invader in the Sasunavghar forest, is an indication of disturbance of the forest community.
- In Yeur forest (Core Zone) some of the trees (*Morinda, Adina, Randia*) are hardly 1 to 2 meters in height showing somewhat disturbed nature of the community.
- Gautam nagar (area near encroachment – Disturbed Area) shows marked difference in plant community when compared to other sites. A large number of Zizyphus trees and small Terminalias show heavy degradation of the plant community, that is attempted to be restored by forest plantations of teak, Kadamb, Adina, etc.

Landuse Study

Landuse pattern in SGNP was determined from satellite pictures (IRS 1-C LISS III and PAN images of February and March 2000 respectively). Extensive ground truthing exercises were also done for this purpose. The following were the conclusions of the exercise:

- Landuse classification of SGNP shows about 85.29% land in under forests, 2.21% under water bodies, 11.34% under urban / settlements (including those in revenue villages, roads and other settlements) and 1.16% under agriculture.
- There has been a substantial increase in the area under encroachment since the study carried out earlier in 1995 by Space Application Center (SAC), Ahmedabad. After that an extensive demolition work was undertaken as per High Court's order and approximately 80% of encroachment area has been demolished by Forest Department.

2.3.2 Problem Areas and Issues In SGNP and Environmental Management Plan

Activities in and around the park, which could significantly impact the park environment were identified in all three ranges in the park. Other issues in all the ranges that have environmental significance were identified. Also current management practices followed by Forest Department for such issues were described. The issues covered range from encroachment to environmental education and from forest fires to eco-tourism.

Environmental Management Plan (EMP) was prepared and is limited to highlighting the environmental problems in the SGNP area and providing action plans to tackle it

successfully, while implementing the Forest management plan. This plan is supposed to supplement and not replace the existing Forest Management Plan for Sanjay Gandhi National Park. The plan should be dynamic and should be regularly updated by Forest Officials to include new developments in the park.

Details of the problem identification and EMP are given in **Chapters 6 and 7** respectively. **Table 2.1** below, gives a summary of the significant activities/issues identified in the park, their possible impacts, their severity and priority for implementing mitigation measures. Suggested mitigation measures are also included in this table.

2.3.3 Park Monitoring

Baseline values for a variety of parameters for various ecosystems in SGNP were monitored as a part of this study the summaries of which are in Section 2.3.1 above. Regular monitoring of these parameters at pre-determined locations and frequencies in the park is imperative to track health of the forest and its various ecosystems, taking timely action in case of any undesirable disturbances and planning of conservation measures from time to time.

Monitoring programs are suggested for vegetation and soil, surface and groundwater, air quality and noise. The program also includes a bio-monitoring schedule, which is easy to conduct and interpret. Details of these are given in **Annex 7.4.**

The monitoring program suggested is in addition to the existing programs of data collection and monitoring by Forest Department such as animal census, forest fire incidences and many other statistics.

2.3.4 Park Environmental Management System

There are several objectives and goals leading to environmental benefits, which are to be achieved by the Forest Department. To facilitate the achievement of these goals, it is suggested that a formal, documented system be developed. This system may be termed as the Park Environmental Management System. ***The main objective of this system would be to ensure continual improvement in the park environment.*** The system will be a voluntary mechanism on the part of Forest Department to systematically address various environmental concerns of the park. The documented system will also help in demonstrating to the outside world the efforts of the Forest Department towards ecological conservation and restoration.

The system follows the essential elements of the standard ISO 14001. The key ingredients of this system that could be adapted to suite the activities in SGNP are:

a. Constitution of a Core Team to implement and manage environmental programs
b. Definition of Policy or Objectives
c. Define Specific Targets and Action Plans

d. Define Roles and Responsibilities
e. Training of Personnel
f. Developing Operation Procedures / Work Instructions
g. Monitoring and Records
h. Audit and Reviews

More details of the system are given in **Section 7.13, Ch. 7**.

Table 2.1 Summary of Significant Environmental Issues and Mitigation Measures

No.	Activity/Issue of Concern and their Location	Component affected	Potential Impact	Severity	Priority for Action	Mitigation Measures	Implementing Agency	Remarks
1.	**Forest Fires** Locations Entire Park	• Flora of forest • Fauna of forest • Soil (Humus) • Hydrological function of watersheds	Loss of vegetation including regeneration Injury to animals • Changes in soil characteristics • Loss of leaf litter. • Soil erosion etc. • Reduced infiltration • Lower water holding capacity	Moderate Low Moderate Low	High	Prepare Forest Fire Management Plan to include various components given in Annex 3.3 Upgrade fire fighting infrastructure for : - Fire Detection - Communication - Fire fighting tools and equipment - Conveyance - Well trained personnel - Personnel safety apparatus etc.	SGNP	Currently forest department is using fire tracing and fire lines methods as prevention methods. Fire fighting is mainly done by beating fires with tree branches. These methods are not adequate. Forest fire detection and control infrastructure needs urgent upgradation. (Refer Photo 39 in Annex 4A.)
2.	**Soil Erosion** Major Locations: • Encroached areas on park boundary. • Vihar catchment. • Shaikh quarry area in park at Dahisar	• Soil • Lake water	• Reduction of Water holding capacity of the area. • Silting of lakes	Moderate	Moderate	▪ Building Check dams ▪ Nala bunding ▪ Plantations on slopes (Refer Table 7.5, Ch. 7)	SGNP	Forest Dept. has a soil and moisture conservation plan proposed in Draft Forest Mgmt. Plan (2001-10). Plantation is also being done in various areas (see Table 6.6, Ch. 6)

Table 2.1 Cont..

No.	Activity/Issue of Concern and their Location	Component affected	Potential Impact	Severity	Priority for Action	Mitigation Measures	Implementing Agency	Remarks
3.	**Quarrying** Locations Abandoned Shaikh quarry at Dahisar area (SGNP Range) Operating quarries adjoining SGNP boundary at Malad And Dahisar.	▪ Air quality ▪ Wildlife ▪ Soil ▪ Topography and aesthetics	▪ High fugitive dust emission affecting flora / fauna and residential areas. ▪ Noise due to blasting, crushing etc. disturbs the wildlife. ▪ Top soil erosion ▪ Change in topography. ▪ Vibrations due to blasting has caused cracks to boundary wall	High Moderate Moderate Severe HIGH	High	Rehabilitation of abandoned Shaikh quarry located inside the park. As per plan in **Section 7.7, Ch. 7** EMP to be prepared and implemented by existing quarry operators as per **Annex 3.2.**	SGNP SGNP should assure this through the District Collector Indian Bureau of Mines and Director General of Mines Safety (DGMS)	Forest Dept. has made waterholes in the worked out pits in the abandoned Shaikh quarry. This has attracted more wild animals to that area. **(Refer photo 32 to 35 in Annex 4A)**

Table 2.1 Cont..

No.	Activity/Issue of Concern and their Location	Component affected	Potential Impacts	Severity	Priority	Mitigation Measures	Implementing Agency	Remarks
4.	**Encroachment** **Locations** Encroachments are mainly located at park periphery near Malad, Dahisar and Mulund/Bhandup areas. **(Refer photo 36 in Annex 4A)**	• Soil • Vegetation • Wildlife • Forest Resources	• Soil erosion • Deforestation • Proliferation of Weeds • Pollution due to solid waste and sewage disposal • Deliberate fires • Trespassing and disturbance to wildlife habitat • Illegal use of forest resources	High High Low High Moderate High High	High	▪ Demolition of existing structures ▪ Construction of boundary walls to prevent re-entry– work in progress ▪ Plantation to remediate encroached areas after demolition.	SGNP SGNP SGNP	80% of the encroachments in park area have been demolished. Remaining hutments will be demolished after High Court directive. **(Refer photo 37, 38 in Annex 4A for plantation)**
5.	**Illicit Tree felling** **Major Locations:** **Nagla block at extreme north of the Park.**	▪ Vegetation ▪ Soil ▪ Wildlife	▪ Change in vegetation pattern. ▪ Proliferation of weeds. ▪ Soil erosion and decrease in Soil moisture ratio. ▪ Disturbance to wildlife habitat	Moderate Low Moderate	High	▪ Roads up-gradation ▪ Weapons for staff for surveillance and personal protection ▪ Construction of new checkpoints. ▪ Use of motorboat for surveillance near bassein creek area. ▪ Mobile squad	SGNP	This has been planned for and mentioned in the Draft Forest Mgmt. Plan (2001-10). Implementation to begin on high priority.

Table 2.1 Cont..

No.	Activity/Issue of Concern and their Location	Component affected	Potential Impacts	Severity	Action Priority	Mitigation Measures	Implementing Agency	Remarks
6.	**Grazing** Locations Vanicha Pada, Chenna and Yeur villages, Nagla block	Forest resources	Conflict between domestic and wild animals.	Low	low	Increased surveillance by forest officials to prevent further increase in grazing on forest land	SGNP	Mainly the problem of Yeur range. The cattle population from the adjoining areas does not penetrate deeply into the park but they make use of the outer fringes. Grazing is not regulated inside this division. The grazing is prohibited in the notified area of the park.
7.	**Agriculture** Locations Vanicha Pada, Chenna and Yeur villages, Nagla block	Forest resources	▪ Man – animal conflict ▪ Loss of forest land	Negligible	Low	Increased surveillance by forest officials to prevent further increase in agriculture on forest land	SGNP	Agriculture is mainly practiced on forestland by Adivasis residing in and on fringes of SGNP. **(Refer photo 23, annex 4A.)**
8.	**Weed / Termite Problem** **Locations** **Entire park**	Vegetation	Degradation of vegetation	Low	Low	Develop and implement a Pest Management Plan to fight termite and other infestations Implement weed control program given in Draft Forest Mgmt Plan (2001-10) Steps include uprooting, clearing weeds and planting area with suitable local fruit / fodder species useful to wildlife.	SGNP	Currently no specific weed and termite control measures are available in SGNP. **(See photo 40 in Annex 4A)**

Table 2.1 Cont..

No.	Activity/Issue of Concern and their Location	Component affected	Potential Impacts	Severity	Action Priority	Mitigation Measures	Implementing Agency	Remarks
9.	**Lake Catchment Protection**	Tulsi catchment Tulsi lake	Tulsi catchment area is well preserved and can be considered as a control area.	--	--	At present no need for mitigation	--	**Refer photo 4 to 6 in Annex 4A.**
		Vihar catchment Vihar lake	Vihar catchment area is degraded to some extent with soil erosion problem in many patches.	Moderate	High	Catchment area protection as per plan in **Section 7.4.3, Ch. 7.** Plantation to prevent soil erosion	MCGB and SGNP	
			Trespassing in certain sections of Vehar lake from surrounding squatter settlements leading to microbial contamination of lake water.	Low	High	Strict surveillance on eastern side of catchment area (near MCGB access road to prevent entry of trespassers.	MCGB	
		Powai Lake	Lake water is polluted due to discharge of sewage and other industrial wastes from residential and other areas in the catchment.	High	High	Lake remediation action plan as per **Section 7.4.4, Ch. 7.**	Stake holders such as MCGB, local residents etc.	Powai lake is not located in the park area. However, studies were carried out for comparison purposes.

Table 2.1 Cont..

No.	Activity/Issue of Concern and their Location	Components affected	Potential Impacts	Severity	Action Priority	Mitigation Measures	Implementing Agency	Remarks
10.	**Residential premises inside Park Boundary (including Pada's and Forest Quarters)**	• Aesthetics • Soil and Land • Surface water	• Land and surface water contamination from open dumping of **municipal solid waste.** • Disturbance to wildlife, forest fires etc. due to trespassing by Pada dwellers.	Moderate Moderate	Moderate	Segregation of waste at source and composting of biodegradable waste. Sale as scrap / Disposal of non-biodegradable fraction. Increase surveillance by forest guards.	SGNP	Littering of domestic solid wastes such as plastic bags and garbage was observed near the Pada's and Forest quarters. **Refer photo 31 in Annex 4A.**
11.	**Revenue Villages and other properties inside the Park area. (Yeur and Chenna Villages, Air Force Station)**	• Vegetation • Wild animals	▪ Trespassing and deforestation ▪ Land and surface water contamination from open dumping of **municipal solid waste** ▪ Forest fires by trespassers	Moderate Moderate Moderate	Moderate	▪ Increase surveillance by forest guards. ▪ Segregation of waste at source and composting of biodegradable waste. Collection of non-biodegradable fraction by MCGB	SGNP through TMC and Vasai Council	Yeur, Chenna village, are not part of SGNP and are controlled by respective municipal authorities. **See photo 43 in annex 4A.**

Table 2.1 Cont..

No.	Activity/Issue of Concern	Components affected	Potential Impacts	Severity	Action Priority	Mitigation Measures	Implementing Agency	Remarks
12.	**Industries On the periphery**	Air Quality	Impact on flora and fauna due to air pollution	Low to negligible	--	--	--	Most industries are medium scale chemical and engineering in nature. Impact is limited to air pollution only from these industries.
	Inside SGNP (MAFCO)	Land and soil Ground and surface water	▪ Disposal of animal (carcass's) and other solid wastes on land. ▪ Surface and ground water contamination due to effluent and solid waste disposal.	High	High	MAFCO unit has been closed and Forest Dept. intends to convert the area into Nature Interpretation Centre and camping area. The following action is suggested: ▪ Remediation of degraded area such as the septic effluent ponds, contaminated land etc. ▪ Plantation on degraded deforested patches. ▪ Develop plan to convert existing factory infrastructure	SGNP	To take-up conversion of MAFCO infrastructure into Nature Interpretation Centre on a Fast Track. SGNP to prepare a techno-commercial feasibility report for obtaining funds from GOM / GOI / World Bank / Private Corporations. See photos of surroundings of MAFCO unit in **annex 4A, photo 28 –30.**

Table 2.1 Cont..

No.	Activity/Issue of Concern and their Location	Components affected	Potential Impacts	Severity	Action Priority	Mitigation Measures	Implementing Agency	Remarks
13	**Tourism**	▪ Wildlife ▪ Land and soil ▪ Air quality	▪ Disturbance to wild animals. ▪ Increased incidences of forest fires. ▪ Littering of solid waste ▪ Degradation of air quality due to vehicular emissions.	Moderate Moderate Moderate Low	High	Implementation of proposed Eco-Tourism Plan of Forest Department (**See Section 7.10, Ch. 7**) The plan includes creation of new tourism zones, upgrading tourism infrastructure, training etc. Plan outlay is about 20 cr. Suggestion while implementing this plan are also given in **Section 7.10**	SGNP	Amenities available for tourists are very meager. There are no cafeterias and sanitary facilities in the tourism zones. Camping sites and locations are very few and not maintained. A lot of attention and resources are needed for improving tourism amenities in the park. **(See photo 25 –27 in Annex 4A)**
14	**Wildlife Management** **<u>Location:</u>** **Entire park**	▪ Wildlife and their habitat	▪ Disturbance to wild animals. ▪ Insufficiency of space and prey for wild animals. ▪ Destruction of their habitat due to encroachment, quarring, tree felling etc. ▪ Man – animal conflict	Moderate Moderate High Moderate	High	Construction of boundary walls on more sensitive areas. Prey, predator ratio should be maintained. Develop more grassland for various herbivorous preys by clear felling of trees at appropriate locations. More surveillance to prevent poaching. Redesign and enlarge cages of animals in safari and in deer park etc.	SGNP	**Refer Annex 7.4, which provides proposed programs by forest dept. for improving wildlife management.** **See photo 2, 3 in annex 4A.** **Refer photo 26 in annex 4A for Deer park.**

Table 2.1 Cont..

No.	Activity/Issue of Concern and their Location	Components affected	Potential Impacts	Severity	Action Priority	Mitigation Measures	Implementing Agency	Remarks
15.	**Park Security and Surveillance**	Security and Surveillance is important to prevent trespassing, encroachments, illegal felling of trees, prevent poaching, detection and quick response to forest fires and many other related issues	Lack of or inadequate security in the park can aggravate all issues mentioned in the previous column and compromise park ecology.	High	High	Specific recommendations for upgrading communications network by MELTRON; up-gradation of arms and ammunitions by WWF; construction of boundary walls as per High Court orders etc., should be implemented as soon as possible.	SGNP	Security in the park area needs a lot of improvement. Infrastructure such as communication (wireless sets), arms and ammunition, fast conveyance, watch towers etc. are totally inadequate and are major roadblocks hampering discharge of the security function by forest staff.

Chapter 3 PARK DESCRIPTION

3.1 INTRODUCTION

Sanjay Gandhi National Park (SGNP) also known as the Borivali National Park, is a small part of Mumbai City, yet this tiny place on the face of our planet is a masterwork of the natural world. Mumbai is one of the few cities in the world to have such an immense expanse of greenery within its municipal limits. SGNP is of incalculable value to those who seek it. This green oasis, with its rich biodiversity, its picturesque landscape, its lakes and streams, acts as a respite to millions of inhabitants of this concrete jungle from the drudgery of a hectic yet monotonous existence.

This forest has got historical background dating back to the 4th century BC. The forests are mostly moist deciduous type of forests and in general they are dense through out the area. The park not only caters to the aesthetic, recreational and educational needs of the city but also two lakes that lie within it, fulfill a small portion of the water requirement of the metropolis. SGNP possesses superlative natural beauty and is a constant test of our wisdom and foresight to preserve as a treasure for all people.

3.2 LOCATION

The park covering an area of 103.09 sq. km, lies partly in Thane District and partly in the Bombay Suburban District. The actual ordinates of the area lie between 72° 50' – 72° 58' E longitude and 19° 8' – 19° 21' N latitude. Location map of SGNP is given in **Annex 1.1.**

As per Wildlife Institute of India's Bio-geographic classification, SGNP falls in "The Western Ghat Bio-geographic Zone – 5". The Bio – geographic province is "The Malabar Coast – 5A". It is one of the least protected Bio – geographic Zone in India,though rich in floral and faunal life.

3.3 BOUNDARIES

Map of SGNP is given in **Annex 1.2**. The Bassein Creek divides the Park unequally into two blocks namely the North and the South Block. Vihar lake is situated at the south extremes of the park whereas Nagla block is at the north extremes of the park, beyond the bassein creek. Nagla block roughly occupies 10 percent of the total park area. The main block, is around 87 sq. km.

Aarey Milk Colony, Film city and the Bombay Natural History Society (BNHS) are the important landmarks, which adjoin the southern end of the Park whereas the Gokhivara, Mandvi and Bhiwandi ranges of the Thane Forest Division adjoin the Nagla Forest Block of the National Park at the northern end.

3.4 AREA

Presently the park extends over an area of 103.09 sq. km. and can be divided as follows:-

1) Area under Bombay Suburban District 44.45 sq. km.
2) Area under Thane District 58.64 sq. km.

The Park came into existence by piecing together the land of the following various classification as described below in **Table 3.1.**

Table 3.1 Classification of Lands in SGNP

S.No.	Category	Area in sq. km.
1.	Original Reserved Forests as per Indian Forest Act, 1927	47.00
2.	The Municipal Forests or Tulsi, Vihar lake Catchment Area (Reserved Forests)	10.00
3.	Private Forests Acquired under Maharashtra Private Forests (Acquisition) Act, 1975 (Reserved Forests)	14.97
4.	Private In term Acquired under Land Acquisition Act, 1894 (Reserved Forests)	10.26
5.	Revenue Land Transferred from Aarey Milk Colony to Forest Department (Un classed Forests)	20.76
6.	Protected Forests	0.10
	Total	**103.09**

3.5 CLASSIFICATION

The classification of the total area of the Park has been done under the following heads:-

a) According to the Forest Type

Table 3.2 - Classification as Forest Type

S.No.	Forest Type	Area in sq. km.
1.	Reserved Forests	81.51
2.	Protected Forests	0.21
3.	Un – classed Forests	21.37
	Total	**103.09**

b) According to Management and Administrative convenience

The area of the park division is divided into three territorial ranges for management and administrative convenience. Each range is divided into rounds and each round is divided into beats.

Table 3.3 - Administrative Classification of SGNP

Sr.No	Category	Number
1.	Compartments (units of management)	38 (20 in Thane District and 18 in Bombay Suburban)
2.	Territorial Ranges	3
3.	Territorial Rounds	9
4.	Beats	25

Source: Forest Management Plan for 1994 –99

According to the Ranges

Table 3.4 - Range Classification of SGNP

S.No.	Range	Forest Type	Area in sq. km.
1.	Krishnagiri Upvan	a) Un – classed	5.88
2.	Sanjay Gandhi National Park	a) Un – classed b) Reserved	15.49 23.08
3.	Yeur	a) Protected b) Reserved	0.21 58.43
	Total		**103.09**

Source: Forest Management Plan for 1994 –99

c) According to the Zones

The park has been demarcated into zones to ensure harmony between visitor use and the objectives of the National Park.

Table 3.5 (A) - Zonal Classification of SGNP

Sr. No.	Zone	Characteristics	Area in sq. km.
1.	Core Zone	• Comprises of distinct vegetation types, wildlife habitat and areas with potential for research and study and which need to be preserved	28.176
2.	Buffer Zone	• Serves as a protective barrier around the Core Zone • Has the objectives of maintaining the watershed of the major river and nallah system, preserve the viable population of flora and fauna with special reference to endangered indigenous species	66.25
3.	Tourism Zone Comprises of :- a) Existing Recreational Zone or Krishnagiri Upvan b) Proposed Ghodbunder Sector c) Proposed Majiwade Sector	• Caters to the recreational, educational and aesthetic needs of the visitors	8.66 5.88 1.53 1.24

The Map showing the various Zones of the Park is given in **Annex 1.3.** As per draft forest management plan for the year 2000 –10 the whole park division has been divided into 4 zones. This zonation has been done so as to prescribe suitable treatments for various types of areas of this division.

Table 3.5(B) Proposed Zonal Classification of SGNP

Sr. No.	Zone	Characteristics	Area in Hectares
1.	Core Zone	Includes undisturbed reserved forests, rich in biodiversity, harbouring key species, mangrove ecosystem etc.	7681.031
2.	Conservation Developmental Zone	Areas adjoining the external boundaries. The zone will act as interfaces between the core zone and the people residing outside but near the external boundary.	45.470
3.	Eco- restoration Zone	This includes the areas that are subject to severe biotic pressure or the areas which after having subjected to such pressure, have been restored to SGNP division.	1994.353
4.	Multiple Use Zone	Nature tourism will be promoted in this zone. It consists of un-classed and protected forests.	588.547

Source: Draft Forest management Plan for 2000 –2010.

Landuse classification of SGNP

For determining landuse classification in SGNP, satellite images of the park for the month Feb'2000 were obtained from NRSA, Hyderabad and analyzed. It was found that about 85.79% land is under forests, 2.21% under water bodies, 11.34% under urban / settlements and 1.16% under agriculture. This position would now have slightly changed with a substantial amount of illegal settlements being demolished inside the park in the year 2000-2001.

More details on landuse classification is given in **Chapter 4**, section 4.6. Satellite images and land use classification map of SGNP is given in **Annex 2.19 & 2. 21**. Pie chart of the landuse classification of SGNP is given in **Annex 2.22.**

3.6 PARK HISTORY

This forest has got historical background dating back to the 4th century BC. The diversity of habitats and species contained within the confines of this park led to its recognition as a National Park in 1969 and was renamed as Sanjay Gandhi National Park in early 80's. The park has actually been formed over the years by piecing together private and government owned land.

Out of the total 103.09 Sq. Km area of SGNP, an area 86.96 Sq. Km was notified with the intention of setting up a National Park vide Govt. Notification on 4th Feb 1983, while 5.75 Sq.Km has been set-aside for recreation. The remaining 10.38 Sq. Km was assigned as a buffer zone. Chronological historical highlights are provided in **Chapter 5.**

3.7 GEOLOGY and SOIL

The area comprises of mainly basic lava flows. These are commonly referred to as the 'Deccan - Trap'. They have been dated as between 45 to 60 million years. Basalt rocks, constitute the main ridge extending from Ghatkopar, Vikhroli, East of Jogeshwari, Aarey to Kanheri and beyond and indicate a dip of 10' – 20' towards the west. At places there are ash beds intervening between the successive flows of basalts and they can be seen in the cuttings of the new highway passing through Jogeshwari. Another interesting geological feature of the area is the occurrence of thick volcanic agglomerates near Tulsi lake and Kanheri Caves indicating a possible volcanic focus.

It is seen that the rock structure within the Park is mostly impermeable and non – porous with the exception of the areas adjoining Tulsi and Vihar Lakes. Though the area receives high rainfall, due to such rock structure there is less seepage of water. The streams and few waterholes start drying up as soon as monsoon is over.

Soil - Only a thin mantle of soil covers the volcanic rocks underlying the region particularly on the ridges and other places where years of erosion have steadily worn it away. In some places, fairly large areas of the hard, dry rocks are completely exposed as at Kanheri caves and their vicinity. On the tree clad lower slopes of Vihar and Tulsi catchment area, a good part of Chenna Private Forest and Nagla Block, the soil is sufficiently deep and fertile

3.8 TOPOGRAPHY and TERRAIN

The terrain is largely semi mountainous with only a few patches of level ground, mainly the intervening space between Tulsi and Vihar Lakes, the lower westerly reaches of Krishnagiri Upvan and a small stretch towards the northern end of Chenna Private Forest area nearer to the Bassein Creek. The hills constitute the outer spur of the Sahyadris. Rising from an elevation of less than about 30 meters above mean sea level, the terrain culminates into a series of peaks dispersed through the Park; the highest near the Kanheri Cave being 484 meters. **Photo no. 1** in Annex 4A. shows a view of forest from the top of the Kanheri Caves. **Photo 2**, shows Bhend Nallah in the Yeur Range.

The dominant topographical feature at the southernmost part of the park is the peripheral range of hills, both along the eastern and western limits of the park. The western hill range rises upto Pawamal (344 m) and then leads on westward to end on the Krishnagiri Upvan plains.

The terrain to the north of the Bassein Creek is also hilly, the ridges having a general north – south trend. The highest point is at Kuradai hill and is about 260 m above sea level.

3.9 SGNP THROUGH SEASONS

With its seasonal cyclical changes, the Sanjay Gandhi National Park habitat is fascinating at any time of the year. Over 2000 mm of rainfall is recorded in slightly over one hundred days.

The mean annual temperature is 27 ^{0}c. The weather is usually fine and normal from November to the end of February. April and May are usually warm period. The high temperature from March to June and the dryness in weather, are the factors which make the park prone to forest fires.

In monsoon, one can enjoy greenery, wilderness, waterfalls and streams. As the summer sun dries up the major and minor streams in the forest, water scarcity problem arises and at such time one can go for serious mammal tracking. In each season nature changes its beauty in SGNP.

3.10 FEATURES OF SGNP

3.10.1 Flora and Fauna

3.10.1.1 Flora

One of the unique features of the park is the existence of wide variety of vegetation types such as moist teak bearing, southern moist mixed deciduous, mangrove and western sub-tropical hill forests. **Photo** 3 shows the dense forest area in KUP range.

Moist Teak bearing forest-

It occurs in 3.5% of the area. These forests exist where the soil condition is good. These forests are mostly concentrated in Yeur and Ghodbunder rounds. Earlier, the Nagla block had vast areas of thick teak forest, but they have been almost wiped by illicit cutting.

Proximity to the seacoast and presence of many watercourses and favourable geological factors provide conditions for diverse plant communities. The fresh water lakes and tidal creeks help to diversify the vegetation. Nearly 300 species of medicinal and economically important plants are recorded in SGNP. This rich and diverse forest holds more than a thousand species of plants. Detailed list of flora found in SGNP is presented in **Annex 1.4(A)**. The important species of this forest are listed below in **Table 3.6.**

Table No. 3.6 List of Important Floral Species in SGNP

Sr. No.	Category	Name of the Species	Local Name
1.	Tree	*Tectona grandis*	Teak
2.		*Garuga pinnata*	Kakad
3.		*Mimusops hexadnra*	Ranjan
4.		*Lannes grandis*	Shemat
5.		*Schleichera oleosa*	Koshimb
6.		*Mangifera indica*	Mango
7.		*Adina cordifolia*	Hed
8.		*Ptercoarpus marshpium*	Bija
9.		*Bombac malabarica*	Sawar
10.		*Syzygium cumini*	Jambul
11.	Shrubs	*Carissa carandus*	Karvand
12.		*Helicteres isora*	Murudsheng
13.		*Adathoda vasica*	Adulsa
14.		*Thespesia lampas*	Ranbhendi
15.	Climbers	*Abrus precatorius*	Gunj
16.		*Climatis triloba*	Ranjai
17.		*Zizyphus rugosa*	Toria
18.	Bamboo	*Dendrcalamus strictus*	Manvel
19.		*Bambusa arundinacea*	Katas
20.	Grass	*Cynodon dactylon*	harali
21.		*Dicanthium anulatum*	Ranbangdi
22.		*Coix gigantea*	Ranjondhala
23.		*Eragrostis sps.*	Darbha
24.		*Panicum glabrum*	Varai

Source: Draft Forest management Plan for Year 2000 –2010.

Mangroves scrubs –

Bassein creek runs over a length of about 41km. However 23% of it consists of mangrove coverage (National Institute of Oceanography, Goa, 1998). The creek passes through the SGNP. The extent of mangrove forests included within the boundaries of this area is not precisely known. *Avicennia marina* is dominating the vegetation and has stunted growth.

3.10.1.2 Fauna of SGNP

Wildlife habitats in SGNP support a wide variety of herbivores, carnivores and omnivores. Nearly 43 species of mammals belonging to 8 natural orders and 17 families are reported in the park. Out of these, 8 species are of "endangered" status as per *Schedule – 1 and Part II of Schedule – II of the Wildlife Protection Act, 1972*. These species are listed in **Table 3.7**. Also recorded are 251 species

of birds, 38 species of reptiles, 150 species of butterflies and 9 species of amphibians. Panther is the only big cat found in the area.

Table 3.7– Endangered Faunal Species

Sr. No.	Common Name	Scientific name
1	Panther or Leopard	Panthera pardus
2	Rusty – spotted cat	Felis rubiginosa
3	Jungle cat	Felis chaus
4	Small Indian Civet	Viverricula indica
5	Common Palm Civet	Pardoxurus hermaphroditus
6	Jackal	Canis aureus
7	Four horned Antelope	Tetraceru quadricornis
8	Mouse Deer	Tragulus meminna

Source: Draft Forest Management Plan 2000-10

Out of the above listed endangered species, the rusty spotted cat is a 'Rare species' seen in the park.

Avifauna of the area is an attractive wildlife feature and SGNP is a bird watchers paradise. More than 250 bird species, both resident & migrant, belonging to 18 different orders and 47 families have been recorded here. 5 endangered species of birds have been noticed in the park.

Table No. 3.8 Endangered Bird Species in SGNP

Name of Species	Local name
Pavo cristatus	Peafowl
Pandion haliaetus	Osprey / Fish eating eagle
Haliaetus leucoquaster	White bellied sea eagle
Accritidae sps.	Hawks

According to Bombay Natural History Society (BNHS) members there are *more butterfly species in this marvelous forest than in the entire United Kingdom!* September to January is the best time to observe them. BNHS have recorded the presence of *Atlas Moth* in SGNP, in September 1999, which is regarded as a valuable discovery.

List of flora, mammals, birds, fishes and other wildlife found in SGNP is provided in **Annex 1.4.** Forest department does an annual estimation of wild life population. Last few years figures are summarized in **Table 3.9** below.

Table 3.9 – Population Estimation of Major Wild Animals

No.	Name of animal	Year- 1997	Year- 1998	Year- 1999	Year- 2000
1.	Leopard	36	40	41	38
2.	Sambar	97	95	68	92
3.	Chital	142	232	09	55
4.	Bhekar	41	24	05	15
5	Monkey	559	334	323	295
6.	Wildboar	114	61	22	13
7.	Wild cat	07	03	02	--
8.	Sayal	01	03	--	--
9.	Wolf	05	06	15	07
10.	Peacock	78	43	46	07
11.	Owl	18	09	10	--
12.	Hare	53	34	20	47
13.	Bat	27	-	-	--
14.	Mongoose	-	35	10	19
15.	Eagle	-	01	-	--
16.	Ajgar (Python)	-	02	-	01
17.	Taras	-	02	-	--
18.	Dhaman	-	-	01	01
19.	Wild hen	97	95	68	25

(Source – Animal Census Division, SGNP)

3.10.2 Water Resources

The major surface and ground water resources in SGNP are:

3.10.2.1 Lakes

Tulsi and Vihar lakes are two man-made lakes in SGNP, which are more than a 100 years old. Currently only about 18 MLD or 0.3% of Mumbai water supply comes from Tulsi lake. Vihar lake supplies about 68 MLD or 1.2 % of Mumbai's water. Since both the lakes are rain fed, water levels depend heavily on good monsoon. Though these lakes are geographically situated within the national park, their waterspread areas are under control of Municipal Corporation of Greater Mumbai (MCGM). The 3 lakes in the Park and its vicinity are described below. The morphological details of the lakes are given in **Annex 1.5.**

Tulsi Lake :

Location: It is situated in core forest area of SGNP. It is bounded by forests of Yeur and Pachpakhadi, in the north and east. On the west by forest areas of Magathane and Poisar and on the south the lake is surrounded by Gundgaon forest. Tulsi having enjoyed over 100 years of watershed protection since its impoundment is surrounded by lush green tree growth. See **Annex 1.2** for location of lake.

History: This lake was artificially constructed in 1873 by building a masonry dam across the mouth of a narrow valley and raising an earthen and stone bund across the low lying land between two ranges of hills, thus storing up the waters which came from the surrounding hills. This lake is on the up-stream side of the Vihar lake. The overflow from Tulsi discharges into Vihar lake located to the south.

Catchment: Tulsi Lake and its catchment is depicted in **Photo 4 in Annex 4A.**. The lake is surrounded by hillocks. The vegetation on the hill slopes is thick and lush. The vegetation in the catchment is undisturbed and the primary type of forest is moist deciduous. Predominant vegetation is of Teak, Bamboo and Morinda species. There are no polluting sources located in Tulsi catchment, which can affect Tulsi lake waters significantly.

The catchment area of Tulsi Lake comprises of 745.25 Ha. Landuse map of Tulsi Lake and surrounding area, prepared from satellite imagery pictures (more details in **chapter 4**) is given in **Annex 1.6(a)**. Lake catchment boundary map from MCGB catchment area maps, was superimposed on these landuse maps to give the catchment landuse map in **Annex 1.6 (b)** and Landuse pie-chart in **Annex 1.6 (c)**. The landuse calculated was forest (46.66%), Shoreline vegetation (9.83%), Water body (10.56%) and Dry (Open) forests (32.95%).

Water treatment plant operated and maintained by MCGB is located at the southern lake boundary. The approach road to the lake forms a ring road around the lake. A guesthouse "Log Hut" is located on top of the western hillock. Apart from the roads, log hut and water treatment plant there are no built-up areas in the Tulsi Catchment. The entire catchment is protected and unauthorised entry is strictly prohibited by MCGB and SGNP.

VIHAR LAKE:

Location: Vihar lake is situated at the south corner of national park. Gundgaon forest separates Vihar Lake from Tulsi.

History: Vihar lake was impounded in 1860 by the Government as a result of increase in water demand and water supply shortage.

Catchment: Vihar lake and its catchment is depicted in **Photo 5 in Annex 4A.** The catchment and water spread area of Vihar is the largest among the 3 lakes. The forest density in Vihar catchment is much lower than that of Tulsi lake, making it more prone to soil erosion. The catchment area of the lake was found to be covered with degraded, in few areas moist deciduous forest patches. Rest of the catchment had tree plantation done of exotic species like Australian acacia and Gliricidia sps. Human interference at many locations was noticed during the sampling periods. Although the catchment is protected, intrusions by surrounding settlements are quite frequent. Instances were observed of people from surrounding squatter settlements using lake water for washing, bathing and other domestic uses.

The catchment area of Vihar Lake comprises of 851.488 Ha. Landuse map of Vihar Lake and surrounding area, prepared from satellite imagery pictures is given in **Annex 1.7(a)**. Using the same methodology as given for Tulsi lake, catchment landuse map and pie-chart for Vihar were prepared. These are given in **Annex 1.7 (b)** and **(c)**. Vihar lake and its catchment consists of forest (32.85 %), Shoreline vegetation (2.02 %), Water body (48.96 %), Urban (0.5%) and Dry (Open) forests (15.67%).

POWAI LAKE

Location: Origin of this lake is the Mithi River. This lake is situated just outside the southern park boundary.

History: Powai scheme was taken up on a tributary of the Mithi river,as an emergency measure to mitigate the anticipated water scarcity in 1891. Currently Powai lake water has degraded considerably and is not used for drinking purposes.

Catchment: Powai lake and its catchment is depicted in **Photo 6** in Annex 4A. Although Powai lake is not included within SGNP boundary, certain parameters were studied to draw comparisons between a disturbed lake and the lakes in relatively more pristine conditions.

Due to rapid urbanisation, the Powai catchment consists of mainly built-up land. Water depths in Powai Lake have reduced to barely 3 to 4 meters due to large amount of sewage and silt received from surrounding residential and industrial areas. Considerable amount of wastewater (mainly domestic) finds its way into the lake.

Landuse maps of Powai lake and its surrounding and Powai Lake catchment are given in **Annex 1.8 (a)** and **(b)** respectively. Pie chart of catchment landuse is given in **Annex 1.8(c).** The landuse calculated was forest (42.21%), Aquatic vegetation (12.64 %), Water body (23.15 %), Urban (17.94%) and Open area (4.06 %).

3.10.2.2 Major and Minor Streams and Water Holes

Most of these streams are monsoon fed and they start drying up in summer season. There are about 28 nallahs/ streams inside park area. The two major streams originating in the park are the Revat nallah and Dahisar river. **Dahisar river** originates near Tulsi lake and flows across SGNP through Magathane forest area and joins the Manori creek to the north west of Dahisar village. Few perennial waterholes were observed in Dahisar river bed. The catchment area of the river is spread over 2025 ha. Dahisar river is impounded near the entrance of the park, however in summer the stream and the water collected near the impoundment dries up.

The Revat stream starts from Avaghada hill to the south west of Yeur village, flows towards north through reserved forests of Yeur & Chenna village and finally joins the Bassein creek. This stream after its source acquires different names as it flows through various forest areas. The catchment area of this stream is spread over 2225 ha within the park. In monsoons, all major and minor streams start flowing and the greenery and wilderness of forest is a treat to watch.

Bassein creek flows from east to west and divides the park in unequal northern and southern zones. The northern part is the Nagla forest block of Yeur forest range. The creek banks have mangrove vegetation.

Water holes – These are ground water sources, used mainly as a drinking water resource for wild life. There are a total of 34 waterholes in the park area. In summer season most of the water holes start drying up and very few water sources remain available for the wildlife. Waterholes are also used by the village (Pada) populations for domestic purposes.

Name of the range	Waterholes	Streams / Nallahs
Yeur	13	22
SGNP	17	3
KUP	2	3

Source: Draft Forest Management Plan for 2000 –10

Wells: There are 9 open wells, 4 bore wells in park premises, however only few of them are in working conditions. For this reason, villagers use water holes to fulfil their water requirements, e.g. *Ambyache Pani* (Mango Waterhole) near Tumnipada.

3.10.3 Archaeological values

Kanheri caves are a major point of attraction for tourists to SGNP but its management comes under Archaeological Survey of India. There are a total of 109 caves and are located within the park. The caves have got a history dating back from 1st century B.C. to 9th century A.D. It had been occupied by a well organized Buddhist establishment of monks on an ancient trade route connecting a number of Indian sea ports. A picture of a section of Kanheri Caves is depicted in **Photo no. 7** in Annex 4A.

3.10.4 Recreational and tourism value

'Krishnagiri' Upvan (KUP) with an area of about 6 sq. km. is reserved as a recreational zone inside the park and all tourism is mainly restricted to this zone. The Lion safari, Tiger safari, Crocodile park, Children's Mini Train are the main attractions of recreational part of park. Gandhi Smarak, boating, gardens and children parks are other attractions in KUP.

SGNP is amongst the highly visited national parks in the country. Visitors can be divided into 3 major categories such as picnicker's, pilgrims and wildlife and nature enthusiasts. Majority of the visitors are in the first category who are mostly interested in recreation. Visitors also include persons attracted by birdwatching, nature photography, wildlife viewing, trekking, archeological sites and numerous other special interests.

Between twenty to thirty lakh Indian and foreign tourists visit the park every year. The peak season for Indian tourists is between October to December and April and May months. Usually weekends and public holidays are crowed days in SGNP. There are total of 19 nature trails through out park area. Details of tourist inflow in SGNP area for last 5 years are summarized in **Table 3.10.** Earlier, Tulsi and Vihar lakes were allowed for all types of tourists, but are restricted areas now. Information center in KUP and two recently started Interpretation centers in Yeur Range are the educational attractions in the Park. **Photo 8** in Annex 4A. displays Interpretation Center at Manpada.

Table 3.10 Tourist Inflow in SGNP

Range	Year	Adult	Amount	Children	Amount
Yeur	1994-1995	17103	34,206	13560	13,560
K.U.P.	1994-1995	695778	13,91,556	600248	6,00,248
		712881	**14,25,762**	**163808**	**6,13,808**
Yeur	1995-1996	16895	33,790	15527	15,527
K.U.P.	1995-1996	1264136	25,58,272	465303	4,65,303
		1281031	**25,62,062**	**480830**	**4,80,830**
Yeur	1996-1997	25850	51,700	13181	13,181
K.U.P.	1996-1997	1095017	21,90,034	389843	3,89,843
		1120867	**22,41,734**	**403024**	**4,03,024**
Yeur	1997-1998	4329 15039	8,658 6,925	18806925	53,358 13,850
K.U.P.	1997-1998	1188981	42,83,102	287300	5,21,270
		1208349	**42,98,685**	**296105**	**2,96,105**
Yeur	1998-1999	22307	89,228	8408	16,816
K.U.P.	1998-1999	1069072	42,76,288	366572	7,33,144
		1091379	**43,65,516**	**374980**	**3,74,980**

Source : Draft Forest management Plan for SGNP (2001-10)

3.10.5 Economic Value

Introduction

While the environment has significant non-monetary values, it is also makes a vital contribution to the economy of the state, e.g. through supplying resources and providing opportunities for recreation and tourism. These values have been only partially determined due to the difficulty of identifying and valuing un-priced contributions. Total economic value can include both "use" (for crops, recreation, flood control, waste assimilation and so on) and "non-use" values, such as the value associated with the satisfaction that environmental resources continue to exist and can be bequeathed to future generations

A major challenge is to develop techniques to better value all the benefits of environmental services so their magnitude can be included in decision-making. Protected areas such as national parks can have direct and indirect financial values in terms of the measurable flows of money generated by human use of the areas. These areas also have values from a broad community welfare perspective. This welfare value is usually determined through estimating the community's willingness to pay for environmental goods and services, rather than only through estimating financial values associated with use.

One of the "use" values of protected areas is recreation. Other use values relate to visiting the site for educational purposes, undertaking scientific research, the gene pool "stored" in the park and more general effects such as water supply protection. As well as use values, protected areas can also have "non-use" values, even for people who do not visit a park. They include "existence values", i.e. the value people gain from knowing the area exists and that its flora and fauna remain in a protected state, and "preservation values", i.e. knowing that it is preserved for future generations

Economic Valuation of the Park.

Determining an economic value for natural resources such as National Parks is extremely difficult as they is no particular commodity in the Park that has well defined demand and supply modes.

Economic valuation becomes more necessary when natural resources are damaged degraded or destroyed as a consequence of chemical or oil spills, leaks or harmful discharges, it may be necessary to establish a monetary measure of damages to society. A market exchange is one approach and perhaps the dominant economic theory used to identify monetary value. Alternative methods are available that do not rely solely on the commodification of natural resources. These alternative and contingent methods have been used by courts in the United States to assign a cost or value when the environment is harmed.

Cost-Benefit Approach

One such approach is the cost-benefit approach. However, the problem with a cost-benefit approach to natural resource valuation lies in the intrinsic nature of the environment and the impossibility of applying a market norm to a bundle of goods that seem to defy commodification. Market prices only measure how much something is valued for exclusive appropriation and use. Many more people may have a strongly expressed value about maintaining public access to national parks in contrast to those comparatively few who see wilderness areas as things to be bought and sold as exclusive vacation resorts.

Contingency Valuation Method

Another method, the Contingent Valuation Method is being though of as a best available procedure. The Contingent Valuation Method involves the use of a valuation survey. The survey describes the environmental asset or natural resource degraded and asks the survey participants to report a willingness to pay a maximum amount of money to avoid injury to the asset or resource. The expressed willingness to pay is, of course, hypothetical and is a source of concern to economists who have studied the process. Empirical studies have been conducted to determine the extent to which survey participants have misrepresented their true values and the results of these studies, though not

conclusive, suggest that Contingent Valuation Method values overstate "real economic commitments" by a considerable margin.

Contingent Valuation uses intangible non-consumptive measures of value. It goes beyond descriptions of value based on strictly common sense views of the market economy. This is consistent with the prior expressed premise of some accounting researchers. Contingent Valuation also has critics who continue to call attention to its numerous potential weaknesses.

Study Done by Indira Gandhi Institute of Development and Research (IGIDR)
A study based on the contingency valuation theory was done by IGIDR entitled " Contingency Valuation of Borivali National Park" in 1995.

The study enquires into the willingness of the residents of Mumbai to pay for the maintenance and preservation of SGNP. A total of 522 households were interviewed after supplying them detailed brochures of SGNP. All income ranges were included in the survey, which was carried out by investigators trained in contingency valuation. The conclusions of the study were:

1. The average willingness of the citizens of Mumbai to pay for SGNP preservation worked out to Rs. 27.28 per household per month. (the minimum and maximum range being 0 and Rs.166 respectively. The two extreme samples were removed.)
2. The respondents were willing to pay these amounts for a period of 5 years.
3. Taking into account the population of Mumbai during mid 1995, the total amount for the year worked out to be Rs. 23.5 million per month. After making adjustments and corrections and discounting the future payments, the net present value amounted to Rs. 103.3 crores per year.

Thus the citizens of Mumbai consider SGNP valuable enough to pay for its upkeep irrespective of whether or not they visit it. They will be willing to pay either in the form of tax or in the form of fees levied at the entrance of the park.

Chapter 4 BASELINE ENVIRONMENTAL QUALITY IN SGNP

4.1 INTRODUCTION

Environmental baseline studies consist of a description of those aspects of the physical, biological and social environments, which could be affected by variety of activities.

Many natural resources in the National Park system could be subjected to unfavorable influences from variety of sources, for example, air and water pollution, urban encroachment, and excessive visitation. Left unchecked, the very existence of the natural communities can be threatened. To help prevent the loss or impairment of such communities, it is necessary to monitor it as a first step. The data serves as a reference at a particular time, which can then be compared with future data to determine environmental trends and to plan mitigation or conservation measures where needed.

SCOPE OF BASELINE STUDIES

As described in the earlier chapter, SGNP is located inside metropolitan areas of Mumbai and Thane and hence is subjected to pollution loads and other disturbances from surrounding urban areas. In this project, the current status of various environmental parameters was studied inside SGNP area. Baseline studies were conducted in core, buffer and disturbed zones of SGNP and on the peripheries of the park. The environmental conditions studied can be grouped under the following heads:

- Air and Noise Environment (Ambient Air Quality, meteorology and noise),
- Water Quality (Surface and Groundwater Quality, Lake water and catchment study),
- Floral Assessment in selected patches of the forest
- Landuse Classification of SGNP, Tulsi, Vihar and Powai lakes.

Environmental baseline studies were carried out for 3 seasons summer, winter and post monsoon. An interim report of the summer and winter analysis results and their interpretation was submitted to MMR – Environment Improvement Society in August 2000. The following sections describe summarized environmental baseline data for all 3 seasons.

SECTION 4.2 AIR ENVIRONMENT

High levels of pollutants in ambient air can have detrimental effects on various sensitive ecosystems in SGNP. The overall objectives of the study were to determine baseline air quality for different parameters, estimating pollution loads and to provide management strategies to minimize air emissions and their impacts.

4.2.1 Air Pollution Sources

Various sources of air pollution inside and in the immediate vicinity of SGNP include:

- Industries: Industries situated outside the park periphery in Malad – Kandivali area, Kolshet, Mulund, Dahisar area.
- Quarry/ mining A large patch at Ovala village, on the boundary of Yeur range. Many quarries are operating immediately adjoining the Malad, Kandivali, Dahisar boundaries of the park.
- Traffic: Tourist traffic inside the park is the only major source of air pollution in SGNP.
- Fire: Forest Fire problem is of concern in SGNP range followed by Yeur range.
- Fuel wood: There are a number of small human settlements inside the park boundary. Villagers residing in the Park are dependent on forest for fuel wood. Also squatter settlements (encroachments) near SGNP boundaries contribute to air emission from domestic fuel burning.

4.2.2 Pollution Loads

Industry: There are no industries inside the park area (except MAFCO- meat processing unit). MAFCO too has been closed and shifted from the park as per High Court directive. A very small DG set is located in the log-hut rest house near Tulsi Lake. Thus there are no industrial sources of significance which will contribute to air emissions inside the park.

Industries at the periphery of the park are mainly chemical and engineering industries. During site visits it was observed that except for one industry (M/s Golden Chemicals) located very close to the forest boundary at Dahisar, no other industry had the potential to cause continuous significant impacts on flora/fauna of the park. This however is a visual qualitative assessment. In case of Golden Chemicals, gas plumes from stacks were found to be impacting directly onto forest land.

Domestic emissions from fuel burning etc. inside the park is also very limited. Only a sparse population of tribals/villagers are located inside the park area.

Traffic: Traffic in the park is mainly from tourist activity in KUP range and in Yeur Village.. As per figures from park authorities daily maximum vehicles at Borivali Gate and Yeur gate are as follows:

SGNP Gate	200 4-Wheelers	200 2-Wheelers
Yeur Gate	150 4-Wheelers	170 2-Whelers

To calculate emissions from these vehicles, emission factors given by Indian Institute of Petroleum were used, which are as follows:

NOx emissions (LMV) = 6.69 gms/km/vehicle
(2 Wh)= 0.05 gms/km/vehicle

CO emissions (LMV) = 2.72 gms/km/vehicle
(2 Wh) = 4 gms/km/vehicle

Daily emissions from vehicles inside park premises will be as follows (considering each vehicle will run about 10 Km inside park) :

Pollutant	LMV (4-wheeler)	2-wheelers	Total
NOx	6.69 x 350 x 10 km/day = 23.4 kg/day	0.05 x 370 x 10km/day = 0.2 kg/day	**23.6 kg/day**
CO	2.72 x 350 x 10 km/day = 9.52 kg/day	4 x 370 x 10 km/day = 14.8 kg/day	**24.32 kg/day**

These emissions are negligible as compared to the emissions from heavy traffic load on the nearby Western Express Highway and Eastern Express highway and are not expected to contribute significantly to deteriorating the air quality. *Air quality inside SGNP is affected by air emission loads in the entire metropolitan areas of Mumbai and Thane and their complex interactions with meteorological conditions. The vast expanse of greenery serves as a carbon sink and also helps vastly in improving the micro-climate of the entire metropolitan area.*

4.2.3 Meteorology

4.2.3.1 Climate & Micrometeorology

The climate of Mumbai is characterized by high humidity nearly all year round, an oppressive summer season and well-distributed and heavy rainfall during the southwest monsoon season, which constitutes about 94% of the annual rainfall. Data from Santacruz observatory was taken as representative for SGNP, Borivali. The last 5 years data (1995 – 1999) at this observatory for rainfall, temperature, relative humidity and atmospheric pressure, is given in **Annex 2.1(A).**

Winds

Monthly wind roses at Santacruz Observatory (for the period 1995 to 1999) are given in **Annex 2.1 (B) & (C)** for 8.30am and 5.30pm respectively. It can be seen that the predominant wind directions during winter and summer months are northwest to southeast. In the monsoon months from June to August the winds predominantly flow from southwesterly and westerly directions.

Humidity

As compared to area outside park, the humidity is slightly high in the park area. From June to October the relative humidity is about 95 %. The driest part of the year is the afternoons during the period from November to February with relative humidity between 50% to 65%.

Rainfall

The park receives precipitation from South - West Monsoon between June and September and some from North – east monsoon in November - December. The mean annual rainfall is 2600 mm. Nearly three fourth of the total rainfall is limited to July – August, thus creating a water scarcity in the park area especially after January.

4.2.4 Ambient Air Monitoring

4.2.4.1 Methodology

Six locations were selected for air quality monitoring; after discussion with forest officials and visits in SGNP. The selected sites were distributed over the core zone (undisturbed zone), buffer zone and disturbed zones. Refer map in **Annex 1.3** for zone demarcations. The selected sites were :-

Locations :
1. Yeur Gate
2. Yeur Village
3. Tulsi Lake (water treatment plant)
4. Bhandup Complex
5. SGNP Entrance (Borivali)
6. Kandivali- Near Encroachment site

Air monitoring site locations are shown in **Annex 2.2.**

Frequency: 24 hours average sampling once a week for 4 weeks for one month in season for all three season.

Parameters: SPM, RPM, NO_x, SO_2. Spot monitoring of CO and HC were done.

Sampling was done with the help of High Volume Samplers at all locations. Indian standards (IS) methods were followed for sampling and analysis. **Photo No. 9** (Annex 4A) shows the air monitoring field work in progress.

4.2.4.2 Results and Discussion

Annex 2.3 (A) and (B) presents annual minimum, maximum and average air quality monitoring results. The National Ambient Air Quality Standards (NAAQS) are given in **Annex 2.3 (C)**. The results are also presented graphically in **Annex 2.4**, for various locations. Seasonal variations in various air pollutants are depicted in histograms in **Annex 2.5.**

Data Evaluation

The SGNP area is demarcated as sensitive area for applicability of (NAAQS).

- The maximum annual average (average of all 24-hr levels) SPM values were observed at Borivali gate (162 $\mu g/m^3$) and Yeur Village (118.5 $\mu g/m^3$). These values exceeded the SPM standards for sensitive locations i.e. 100 $\mu g/m^3$. 24-hr values at various locations in the park area for the whole year varied between 46 $\mu g/m^3$ to 300 $\mu g / m^3$. High concentration at the gate can be attributed to the heavy traffic on western express highway located very close to SGNP (Borivali) gate. Lowest values were observed near Tulsi Lake area.

- 24-hr RPM levels for the year varied between 21.08 $\mu g / m^3$ to 105 $\mu g / m^3$. The highest value of 105 $\mu g / m^3$ was recorded at Yeur village in post monsoon season. Lowest value of 21.08 $\mu g / m^3$ was recorded at Tulsi Lake. The maximum annual average (average of all 24-hr levels) RPM value was observed at Borivali gate (54 $\mu g/m^3$) which is lower than the RPM standard for sensitive locations i.e. 75 $\mu g/m^3$.

- 24-hr SO_2 levels for the whole year ranged between less than 6$\mu g/m^3$ to 14.2 $\mu g/m^3$, which are well within the standards. Highest value was observed at Borivali gate. Annual average values (average of all 24-hr levels) ranged between 4 to 7.3 $\mu g/m^3$. All SO_2 levels were well below the standard for sensitive area (30 $\mu g/m^3$).

- NOx levels ranged between 11.67$\mu g / m^3$ to 37.2 $\mu g / m^3$. The highest levels were found at SGNP (Borivali) gate and are slightly higher than the standard of 30 $\mu g/m^3$. This also can be attributed to heavy vehicle density on adjacent Western Express Highway. The average NOx levels were however within the NOx standards.

- In winter season, air monitoring was carried out at the Borivali main entrance on Mahashivaratri day, when a large number of people visit Kanheri caves. Air monitoring was carried out for all the above parameters. Results were compared with other day readings. Only SPM concentration were found to exceed the limit (153.02$\mu g/m^3$).

- CO values were found to range between 0.25 $\mu g/m^3$ and 0.60 $\mu g/m^3$ through out the year and were found well below the limit. HC levels were observed between 0.009 $\mu g/m^3$ and 0.04 $\mu g/m^3$. Both CO and HC levels were recorded highest at Kandivali.

- As seen in **Annex 2.5,** seasonal variations in concentration levels for various pollutants are not significant.

SECTION 4.3 NOISE

4.3.1 Introduction

SGNP area is a sensitive zone and any unwanted noise has a detrimental impact on wildlife, birds and other living organisms. Major noise emitting sources in the park are tourist activities and tourist vehicles. This however is confined only to the tourism zone of Krishnagiri Upwan, Yeur village area (residential zone) and park areas adjoining major roads and highways.

4.3.2 Noise Monitoring Methodology

Noise monitoring was conducted at the following locations:

Locations: 1. Tulsi Lake
2. Yeur Village
3. SGNP Main Entrance

Frequency : Day and night reading.

4.3.3 Results and Discussions

Summarized data for Noise levels measured at various locations in all three seasons is depicted in **Annex 2.6 (A).** CPCB noise standards are given in **Annex 2.6(B).** Applicable noise standards in SGNP area will be silence zone levels i.e. 50dB(A) for daytime and 40dB(A) for nighttime.

As no major noise emitting sources are present in park, only three locations were selected viz. Tulsi lake (core zone), Yeur Village (buffer zone), and SGNP gate (disturbed zone). The highest day time noise levels in SGNP area was observed at Borivali entrance [65.3 dB (A)] and Yeur Village [58 dB(A)] , which are a little higher than the day time standard of 50 dB(A). Nighttime exceedances were observed mainly at Yeur Village. These noise level exceedances are in pulses and can be attributed mainly to vehicular noise. For majority of the time however, noise levels are within the standards.

SECTION 4.4 AQUATIC ENVIRONMENT

4.4.1 Introduction

As described in previous chapter, Tulsi and Vihar lakes are the major water bodies in the park, which also supply about 658 MLD of drinking water to Mumbai. There are also numerous monsoon fed major and minor streams, water holes, open and bore wells inside SGNP.

In order to evaluate impacts of various pollutants on aquatic ecosystems in the park and devise mitigation/conservation plans, it is important to determine the baseline environmental status of these water resources. Findings of the baseline monitoring exercise are presented below in various sections.

4.4.2 Ground Water and Surface Water Streams

Ground water quality is affected by several parameters such as nature of the aquifer, naturally occurring contaminants and leaching of contaminants from human activities. As groundwater in SGNP is used for drinking water, both by human and wild life populations, it is imperative that the status of water quality be studied and tracked for various chemical and microbiological parameters.

4.4.2.1 Methodology

An Initial survey of SGNP was carried out to determine monitoring locations. The monitoring locations were selected on basis of land use, site surroundings, forest zones (core, buffer, disturbed).

The monitoring locations are given below in **Table 4.1**. The monitoring locations are also shown in **Annex 2.2** for sampling locations:

Table 4.1 Stream and Groundwater Monitoring Locations

Location Details	Range/ Zone	Type	Seasons*
1. Gautam Nagar (Plantation Bawadi)	SGNP range / Buffer Zone	Open well	W, S
2. Mafco Borewell	SGNP range / Tourism Zone	Bore well	W, S, P
3. Ambyache Pani – Tumni pada	SGNP range / Buffer Zone	Waterhole	W, S, P
4. Yeur Village – Open well	Yeur range / Core Zone	Open well	W.
5. Yeur village – bore well	Yeur range / Core Zone	Bore well	W, S
6. Bhendi Stream	Yeur range / Core Zone	Waterhole	W, P
7. Bamboo hut (Bunglow No.9 & 10)	SGNP range / Buffer Zone	Bore well	W, S, P

Location Details	Range/ Zone	Type	Seasons*
8. Air force – Khadan Lake	Yeur range / Core Zone	Small waterbody	S, P
9. Dahisar river – inside SGNP	KUP range / buffer zone	River	P
10. Dahisar river – outside SGNP	Outside the main gate of park at Borivali	River	P
11. Chenna river	Yeur range	River	P
12. Bassein creek	Yeur range	Creek	P
13. Ganeshsagar lake	Yeur range / buffer	Small waterboby	P

* **W- Winter, S- Summer, P – Post monsoon**

Standard APHA procedures were followed for water sampling and analysis. **Photo 10** in Annex 4A, shows the water sample collection task in progress. Monitored values for streams and lakes were compared against ISO 10500 standards for drinking water and CPCB standards for coastal zones for creek water.

4.4.2.2 Results and Conclusions

Ground Water – Analysis results are depicted in Annex 2.7 (A).

- pH ranges between 6.2 and 7.83, this indicates all water samples are neutral in nature. Electrical conductivity varies between 174 to 1050 µm/cm. EC was highest at Mafco borewell and lowest at bamuhut.
- The variations in the characteristics of ground water are; total hardness 76 to 248 mg/l, nitrates 0.001 to 1.5 mg/l, sulphates 1.9 to 135mg/l and alkalinity 8 to 262 mg/l.
- TDS results were found between 154 to 616 mg/lit; highest at Mafco bore well.
- Lead was Nil in all the samples in all seasons. Chloride value varies between 21 to 98 mg/lit.
- Iron ranged from 0.01 to 4.7mg/l. Manganese values ranged between 0.004 to 1.8 mg/ lit.
- In winter season pesticide values were negligible. Pesticides were analyzed for the purpose of establishing baseline values. As there are no major pesticide sources, they were not analyzed again in next two seasons.
- Coliform count varied between 8 to 1800/ 100ml. Mafco, Tumnipada and Gautam nagar water sources showed higher MPN counts. Gautam Nagar (encroachment area) had high MPN and also fecal coliforms indicating fecal contamination. This water should not be used for drinking without treatment.

Stream Analysis – Analysis results are summarized in **Annex 2.7(B).**

- pH ranges between 7.06 and 7.85, this indicates all water samples are neutral in nature. Electrical conductivity varies between 175 to 16640 µm/cm. EC was highest at Chenna River outlet and lowest at Khadan Lake.
- The variations in the characteristics of surface water are; total hardness 54 to 1940 mg/l, sulphates 5 to 28 mg/l and alkalinity 44 to 110 mg/l.
- TDS results were found between 157 to 12064 mg/lit; highest at Chenna river outlet (near creek).
- Lead was Nil in all the samples in all seasons. Chlorides value varies between 17 to 6270 mg/lit (high value near creek).
- Iron ranged from 0.15 to 0.5 mg/l. Manganese values ranged between 0.01 to 0.1 mg/ lit.
- Coliform count varied between 0 to 1800/ 100ml. At Chenna inlet and outlet it was recorded negligible. Remaining places it was recorded more than 1800 coliforms / 100ml this indicates that those water sources are not potable and need treatment prior to use for drinking.

Bassein creek: Analysis results are presented in **Annex 2.7 (C).**
Creek water sample was also tested for variety of parameters. Most of the parameters were found exceeding the limits. Dissolved Oxygen was recorded as 3 mg/lit, which is not sufficient for sustaining aquatic life.

4.4.3 LAKE ECOSYSTEM

4.4.3.1 Introduction

Tulsi and Vihar Lakes are two major surface water bodies present within the boundaries of Sanjay Gandhi National Park. Tulsi and Vihar cathments are one of the finest and total catchment areas of both lakes accounts for roughly 10.00 sq.km. of the park. Detailed description of the lakes and their catchment areas and their history etc. are given in **Section 3.10.2 of Chapter 3.**

Lake Monitoring:
Monitoring programs are a vital aspect for developing effective Lake conservation measures. Lake ecosystem study comprises of study of the lake catchment (Watershed) area, shorezone area, riparian vegetation and in-lake water / biological / sediment assessment. All these parameters were analyzed in detail for Tulsi and Vihar lakes and to a limited extend for Powai Lake. Powai Lake was included in the study mainly for comparing its water quality with that of Tulsi and Vihar lakes, which are located in pristine surroundings.

4.4.3.2 WATERSHED HABITAT :

Watershed includes not only the water resource, such as a stream, river, lake or estuary but also the surrounding land from which water drains to the resource. The watershed or drainage area from which water is collected varies widely from lake to lake. The water from the catchment flows into the lakes through a number of small streams.

The composition of water draining from the catchments depends on factors such as:

- The initial composition and amount of rain
- Different chemical substances, which become dissolved in the water and the reactions between them.
- Lake basin characteristics such as geology, soil etc.
- Human activities in the catchment, such as deforestation and fertilization of land, disposal of wastes, settlements around catchment and other activities.

Detailed description of the lakes and their catchment areas, history etc. are given in **Section 3.10.2 of Chapter 3**.

4.4.3.3 Shore zone Habitat

4.4.3.3.1 Introduction

The shore zone habitat assessment is important for identifying potential causes of impairment because many lakes are impacted by development and land use on the shore. Since the lakeshore is the part of the watershed closest to the lake, shorezone landuse has the largest potential impact on lake biological integrity.

This study was conducted in summer season for parameters such as riparian vegetation, macrophyte and macro invertebrate assessment.

4.4.3.3.2 Riparian Zones

Riparian zone is defined as the non-cultivated, vegetated area between the water body edge and the upland area. Riparian habitats can be identified by the presence of vegetation that requires moist conditions. Microclimate of riparian zones is different that of surrounding environment.

Advantages of riparian vegetation :

- They are generally more productive in terms of biomass of plants and animals.
- Zones of natural vegetation alongside the lakeshore and streams stabilize shorelines from erosion and contribute to the aquatic food source through allochthonous input.

- It acts as effective sink for certain pollutants of agrochemical origin.
- They also reduce non-point pollution by absorbing and neutralizing nutrients and contaminants.
- It provides migration routes for variety of animals.

Observation

No riparian vegetation of significance was observed in all three lakes.

4.4.3.3.3 Macrophytes

Macrophytes form an integral part of the littoral zone (zone between main water body and shoreline) of many lakes, providing cover for fish and substrate for invertebrates. Macrophytes are large plants including aquatic angiosperms, horsetails, water ferns, mosses and large algae. They are sensitive indicators of water quality and conditions of their habitats.

Methodology

For macrophyte studies, different sites having microhabitats were visited along the bank of the lakes and the macrophytes were observed. The samples of macrophytes were collected in herbarium sheets and identified with the help of field botanist. This was a qualitative survey done for the three lakes. **Photo 11** (Annex 4A).

Results and discussion

- In Tulsi lake, the macrophytes seen on the banks included polygonum sps., scroph sps. , Jussiea sps., Calotropis floribunda and Ipomea species (on Wagle estate site only).

- In Vihar lake, at few places Ipomea plants were observed growing at intake well site. At Bhandup complex site Polygonum sp., Jussiea sp.and Ipomea sps. were recorded in very low density and in restricted area. Overall the macrophyte vegetation was less compared to the area of the lake.

- Powai lake has many human activities in the surrounding areas which have affected the lake ecology. The destruction of catchment area of the lake, other construction activities in the area, and sewage waters are responsible for increasing water hyacinth on all sides in the lake. The other weeds such as Ipomea has covered the periphery mainly on the roadside and towards the IIT campus. Other macrophytes like Spermacocea sps., Halidolytis nitida, Arjeyria sps., Calicopteris floribunda were seen growing on banks.

4.4.3.3.4 Macro-invertebrates

Macro-invertebrates were also studied in case of all three lakes. For this, a physical survey was carried out along the bank of each lake. **Photo No. 12** in Annex 4A depicts the survey.

Observations:

- On Tulsi shoreline, a large number of macro-invertebrates were observed, which included dragonflies of three different species, damselflies and whorlgig beetles.
- In Vihar lake, the invertebrates seen included common snails, lemon pancy butterflies, common crow butterflies. Very few insects and other forms were seen.
- Large number of shells was observed in littoral vegetation of Powai lake.

4.4.3.4 Inlake Habitat

Physical – chemical habitat measurement comprises several common measure of lake water quality and can point to water quality problems that are not observable at the coarser resolution of the watershed. Both the lakes are situated in reserved forests area hence the chances of contamination are very low.

Changes in a watershed are mirrored in the quality of water and its regime. The lake water parameters that were assessed include physical and chemical characteristics, temperature and Dissolved oxygen profiles, nutrients, sediments, chlorophyll and other biological indicators.

4.4.3.4.1 Lake Water Quality and Assessment

Assessment of water quality is an important aspect for any environmental study. Pollution in natural water may be disastrous to fishes and other fauna and flora living therein. A lake monitoring program helps to identify water quality problems and quantify pollution loads. Here water quality assessment will help us to define the trophic state of respective lakes and nutrient availability in lake, which in turn will help us to determine any source of pollution in respective watersheds of lakes.

Methodology

Lake water sampling protocol was designed and sampling done as per methods prescribed by United States Environmental protection Agency **(USEPA)** (**Reference No.16 & 17 Annex 4(B)**. As the lakes are protected territory, prior permission was obtained from MCGB for use of their boats. Water samples were collected once from the same locations in summer, winter and post monsoon. Names of locations are listed below in **Table 4.2. Maps presented in Annex 2.8 (a), (b) and**

(c) show selected sampling locations for all 3 lakes. **Photo 13** in Annex 4A shows our team preparing to go for lake monitoring.

Table 4.2 Lake Water Sampling Locations

No.	Vihar	Tulsi	Powai
1.	Intake Well	Intake Well	Ganesh immersion site
2.	Darga	Near Wagle Estate	Near Hiranandani Comp
3.	Pump House	Dam Overflow	Back side of IIT
4.	Bhandup Complex	Near Dam	At the Centre
5.	Tulsi Nallah	At the Centre	--
6.	Centre of lake	--	--

Results and Analysis

Results of lake water monitoring are summarized in **Annex 2.9 (A) to (C).** These are yearly average values for all three lakes. Parameters were compared with IS 10500, 1991 drinking water standards given in **Annex 2.10.**

Vihar Lake:

- pH ranges between 7.51 and 8.5 indicates that water samples are neutral in nature. Electrical conductivity varies from 119 to 423 µs/cm indicates high soluble salts concentration.
- Turbidity variation is in between 3 to 18 NTU. The highest was recorded in post monsoon at the center of lake.
- The variation in TDS- 73 to 275mg/l, total hardness - 44 to 208mg/l, alkalinity- 38 to 83mg/l, chlorides 8 to 28, sulphates 1.3 to 9.0mg/l. All these parameters were well within the limits as per IS10500: 1991. All these parameters were recorded lowest in post monsoon season due to dilution.
- Total Nitrogen and total phosphorus values varied between 0.14 to 12.8 mg/l and 0.014 to 0.92mg/l respectively. This indicates that there is not much nutrient loading in the lake.
- Iron levels exceeded the limit (0.06 to 1.8mg/l).
- In all three seasons Zinc values were recorded below the standard.
- In winter, manganese was recorded higher than the standard (varies between 0.11 to 1.86mg/l) whereas in summer and post monsoon it was recorded below the standard. The highest value was observed at Tulsi nallah site in winter.
- As per standards pesticides should absent in sample. In this lake pesticides were recorded as traces in winter season.
- BOD and COD both values were quite low. Average BOD and COD values were 5.4 mg/l and 15 mg/l.
- All water samples were not potable microbiologically. Some samples (at Darga end) showed very high MPN counts (1600).

- Secchi Disc reading varied between 66 and 160 cm. This indicates that water clarity was more in winter compared to summer.

Conclusion - Vihar Lake water is of good quality, except for slightly increased levels of Iron and Manganese. The water was colorless, odorless and showed slightly high turbidity. Microbiological contamination to some extent was observed due to human interference (washing, bathing etc.) at some lake boundaries.

Tulsi Lake

- pH ranges between 7.03 and 8.5 indicates that water samples are neutral in nature. Electrical conductivity varies from 119 to 361 µs/cm indicates high soluble salts concentration.
- Turbidity variation is in between 4.3 to 18 NTU. In winter it was crossing the limit highest recorded at Dam (18.0NTU).
- The variation in TDS- 73 to 235mg/l, total hardness - 44 to 88mg/l, alkalinity- 36 to 83 mg/l, chlorides 9 to 25, sulphates 1.3 to 10.71mg/l. All these parameters were well within the limits as per IS10500: 1991.
- Total Nitrogen and total phosphorus values varied between 0.14 to 4.76 mg/l and 0.05 to 1.84 mg/l respectively. These values are quite low and indicate that there is not much nutrient loading in the lake.
- Iron levels were 0.05 to 0.1mg/l in summer; 0.05 to 0.3 mg/l in post monsoon and 1.2 to 1.8mg/l in winter. The winter values exceeded the limit of 0.3mg/lit.
- Zinc levels were recorded below the standard, values varied between < 0.005 to 0.9 mg/l.
- Manganese levels were recorded below the limit except at Dam overflow and near jetty site in winter.
- In this lake pesticides were recorded as traces in winter season.
- BOD and COD both values were quite low. Average BOD and COD values were 5.2 mg/l and 13.6 mg/l.
- This indicates very low levels of organic matter in waterbody.
- Samples were found potable microbiologically as per standards. Some samples in winter showed traces of *E. coli*.
- Secchi Disc reading ranged between 95 and 125 cm through out the year.

Conclusion - Tulsi Lake water is of good quality. The water was colourless, odorless and showed slightly high turbidity. Microbiological contamination was absent.

Powai Lake

- pH ranges between 7.1 and 8.2 indicates that water samples are neutral in nature. Electrical conductivity varied from 336 to 529 µs/cm indicates high soluble salts concentration.
- Turbidity variation is between 8.7 to 245NTU that is exceeding the limit, highest observed at the center of lake in summer.

- The variation in TDS is 212 to 344mg/l, total hardness - 130 to 184mg/l, alkalinity- 46 to 194mg/l, chlorides 23 to 65, sulphates 3.57 to 17.0mg/l. All these parameters were well within the limits as per IS10500: 1991.
- Total Nitrogen and total phosphorus values varied between 0.56 to 2.58 mg/l and < 0.005 to 0.84mg/l respectively.
- Iron value ranged between < 0.05 to 0.3 mg/lit. In summer season Iron was found near to the limit (0.25 to 0.4mg/l) but in winter it exceeded the limit (1.7 to 2.0mg/l).
- Zinc values were recorded below the standard.
- Manganese value exceeded the limits in both the seasons except the sample collected from Hiranandani complex site in winter.
- Pesticides were recorded as traces in winter season.
- Average BOD and COD values were 11 mg/l and 28 mg/l. These values were almost double than of Tulsi and Vihar lakes, indicating higher organic loading.
- Water samples were found non- potable microbiologically in all seasons.
- Secchi Disc reading varied between 30 to 40cm through out the year that is very low as compared to Tulsi and Vihar. This indicates poor clarity of lake water, which is matching with the results of TDS and conductivity.

Conclusion - Powai Lake water is of poor quality, very turbid, greenish color due to large number of Phytoplankton. Higher BOD and COD values indicate contamination by organic matter. High MPN values were observed in all samples.

4.4.3.4.2 Lake Sediment Deposition

Streams, storm water runoff, and other forms of moving water carry sand, silt, clays, organic matter, and other chemicals into the lake from the surrounding watershed. Sediments play an important role in elemental cycling in the aquatic environment. Sediment material from the watershed tends to fertilize aquatic plants and algae because phosphorus, nitrogen, and other essential nutrients are attached to incoming particles. If a large portion of the material is organic, dissolved oxygen can decrease as a result of respiration of decomposers breaking down the organic matter. It indirectly affects navigation and recreational use.

Methodology

Samples of deposited sediments were collected at selected sites from Tulsi & Vihar lakes with the help of spatula, in winter and post monsoon. In case of Powai lake, it was collected from the center of the lake with the help of submerged pump. Refer to **Annex 2.8 (a), (b) and (c)** for the lake diagrams showing the sampling site locations. Collected samples were then analysed:

Sediments were collected from the following locations (Table 4.3)

Table 4.3 Lake Sediment Sanpling Locations

No.	Vihar	Tulsi	Powai
1.	Intake well	Intake Well	Centre of the lake
2.	Darga	Wagle Estate	
3.	Pump House	Near dam	
4.	Tulsi Nallah	Dam Overflow	

Results and Discussions

Sediment analysis results are given in **Annex 2.11 (a), (b), (c).**

- For Vihar, Tulsi and Powai, Iron values ranged between 0.031 to 11.61, 0.21 to 16.76mg/kg and 1.8 to 8.89 mg/kg respectively. Post monsoon iron values in sediments increased significantly in all lakes.
- Manganese concentration was lowest in Tulsi (0.01 to 0.25 ppm), moderate in Vihar (0.02 to 0.31 ppm) and highest in Powai (0.11 to 0.55ppm).
- Lead concentration ranged between 0.003 – 0.77ppm for Vihar, 0.003 –0.062ppm for Tulsi and 0.025 – 10.94ppm for Powai. Thus post monsoon lead level was about nine times higher in Powai lake sediments than those of Tulsi and Vihar lakes.
- Oragano-chlorine pesticide was recorded as negligible in all the samples in all three lakes. Organophosphate pesticide was recorded as highest in Powai.
- Chromium and Mercury was recorded as negligible all three lakes.

4.4.3.4.3 Dissolved Oxygen and Temperature

The amount of dissolved oxygen in water is an important indicator of overall Lake Health. When oxygen is reduced, organisms are stressed. When oxygen is absent, all oxygen-breathing life forms must either move to an oxygenated zone or die.

Dissolved oxygen conditions are best characterized by measuring the:

- Dissolved oxygen profile (measurements from the surface to the bottom of the lake at different depths); and
- Temperature profile (at these depths).

Oxygen Profile: A profile of oxygen measurements taken from top to bottom provides insight on the relative populations of oxygen-producing plants and bottom-dwelling decomposers.

Temperature Profile: Water temperature plays an important role in determining the amount of oxygen found in the lake. Oxygen is more soluble in cold than warm water. Thus the cold layer can potentially hold more oxygen than the warmer upper layer. Usually these layers do not mix; thus, the bottom layer is cut off from atmospheric oxygen and oxygen-producing plants. Consequently, bottom oxygen can become depleted if there is an active population of decomposers in the bottom sediments. For these reasons, it is important to define the thermal layers in a lake when characterizing dissolved oxygen conditions.

Methodology-

DO and temperature profiles were measured during summer, winter and post monsoon season for all 3 lakes. Brief methodology and locations etc. are described below:

- Water sampling for DO and temperature parameters were done on the same days on which the lake water samples were collected for physico-chemical analysis. In this study DO and temperature profiles were taken at the centers of all three lakes. All necessary precautions were taken to avoid contact with air at the time of sampling.
- For each of the 3 lakes, water samples were drawn from lake bottom to top at 1 m intervals. In Vihar and Tulsi lakes about 8 to 9 m depth was encountered. Whereas in Powai lake a maximum of only 3 to 4 meters was seen.
- DO levels were analysed titrimetrically at site using a field kit. Standard Methods were followed for this purpose [See **Ref No19, Annex 4(B)]**
- Temperatures were measured on the spot using digital temperature probe.

Results and Discussions

Results of DO and temperature profile measurements for all seasons are presented in **Annex 2.12 (A) to (C)** and graphical presentation is given in **Annex 2.12 (D to G).**

- In case of Vihar lake, D.O. varied from 8.8 mg/l to 6.0 mg/l , 7.6 mg/l to 0.5 mg/l and 7.8 to 6.1mg/l in winter, summer and post monsoon seasons respectively from top to bottom of the lake. In summer, Vihar lake showed a curve, typical of a productive lake. This curve is classically called 'Clinograde curve'. Refer **Annex 2.12-D** that shows clinograde curve. In this, relatively high concentration of Dissolved Oxygen is observed in the epilimnion (surface layer), due to release of oxygen by photosynthesis and also surface dissolution of oxygen. The progressive decrease in the oxygen with depth is related to the productivity in the epilimnion. If the productivity is more, the volume of dead and decaying material that reaches the bottom layer (hypolimnion) is also more. This consumes the oxygen and thus depletion of oxygen is observed.

- In winter and post monsoon season, the Vihar lake does not show such typical curve. Though there is decrease in the concentration of oxygen, it does not tend to zero as in case of summer. Thus Vihar lake was more productive in summer and much less productivity was observed in Winter and post monsoon season.

- Similar pattern of productivity has been observed in case of Tulsi lake. Highest D.O. level was 8.9mg/l that was observed in winter at the depth 1meter from the top. The lowest D.O. level was observed at the depth was 0.6 mg/l in summer season at the depth of 9 meter from the top.

- In case of Powai lake, D.O. varied from 6.6 mg/l to 3.9, 6.2 to 2.9 mg/l and 7.5 to 5.8mg/l in winter, summer and post monsoon season respectively from top to bottom. Powai lake is comparatively shallow lake. The graph for Powai Lake shows decrease in oxygen, with increase in depth. Though the graph is not a typical 'Clinograde'type, it shows considerable decrease in oxygen, in both seasons, suggesting slightly higher productivity in summer than in winter and post monsoon.

- When all three lakes were compared, Powai was found to be highest productive than the other two lakes; indicating higher organic loads.

4.4.3.4.4 Biological Assemblages

Introduction

Physical and chemical parameters are important aspects of water quality monitoring. Similarly bio-monitoring techniques, which are simple, can be used to assess the status of water bodies. The quality of water affects the species composition, abundance, productivity & physiological conditions of aquatic communities. Bio-monitoring methods involve the use of plant & animals to assess periodic changes in environmental water quality. Methods used in this includes the collection, identification & counting of bio-indicator organisms.

Biological assemblages were studied in all 3 lakes for summer and post monsoon seasons. The assessment was done mainly with respect to phytoplankton and zooplankton. Phytoplanktons are the base of most lake food webs and fish production is linked to phytoplankton primary production. Excessive nutrient and organic inputs from human activities in lakes and their watersheds lead to eutrophication. In most lakes, zooplanktons are the central trophic link between primary producers and fish. Zooplankton species richness is reduced under chemical stresses.

Phytoplanktons are autotrophic, prepare their own food by using carbon dioxide and organic compounds from water. These phytoplanktons belong to five major groups such as Chlorophyceae, Bacillariophyceae, Cyanophyceae, Euglenophyceae, Chrysophyceae. Besides the phytoplanktons the zooplanktons present in the water include Protozoans, Rotifers, Copepods, Cladocerans etc.

Methodology

- Bio-monitoring studies were carried out at the three lakes Vihar, Tulsi, and Powai. This study included the plankton analysis of water at five different water sampling sites of each lake.
- The plankton studies were carried out with the help of the plankton net. In this study, sampling mesh size was 25 i.e. diameter of the pore was 60 microns. Use of plankton net involves filtering large quantity of water through the net. The water is filtered through the sides and the plankton can be concentrated in a bottle connected at the lower end of the net. The sample collected is then added with two percent formalin and then used for qualitative and quantitative analysis. Refer **Photo 14** in Annex 4A shows water sampling for plankton analysis.
- Lacky's Drop Method was used for plankton analysis.

Calculations

$$\text{No. of Phytoplanktons/ml} = \frac{\text{No. of organisms counted in all fields X area of cover slip mm}^2}{\text{Area of microscopic field mm}^2 \text{ X no. of fields counted X volume of sample under the cover slip}}$$

For biological evaluation of surface water quality, method given by Th.G.N. Dresscher and H. Van der Mark (1980) was used for finding the saprobic index. In this method, the identification of plankton is restricted to identification upto the 'group' level & not upto species level. Depending upon the presence of particular group or groups, the saprobic state of water body can be determined by using the following formula and standardization table,

The Saprobic Quotient 'x' = C+3D- B- 3A / A+B+C+D where,

A = Ciliates – indicator of polysaprobity
B = Euglenophyceae – Indicator of α mesosaprobity
C = Diatoms + Chlorococcales - β mesosaprobity
D = Peridineae + Chrysophyceae + Conjugales – indicates oligosaprobity.

For each sampling site, saprobic index is calculated. Besides the pollution status of the lake as a whole is given.

Standard Table for Saprobic Index is given in Table 4.4 below

No.	Load	Pollution	Saprobic phase	X
1.	Many organic substances	Very Severe	Polysaprobic	-3 to –2
			Polysaprobic mesosaprobic	-2 to –1.5
		Considerable	α mesosapro /Polysaprobic	-1.5 to –1
			α mesosaprobic	-1 to –0.5
2.	Organic & inorganic Substances	Moderate	α/ β mesosaprobic	-0.5 to 0
			β /α mesosaprobic	0 to 0.5
		Slight	β mesosaprobic	0.5 to 1
			β mesosaprob oligosaprobic	1 to 1.5
3.	Few organic & Inorganic substances	Very slight	Oligosaprobic mesosaprobic	1.5 to 2
			Oligosaprobic	2 to 3

Observations and Data evaluation

Variety of Phytoplankton and zooplankton was observed in microscopic examination. The list is presented in **Annex 2.13** and pictorial presentation of these microscopic views is given in **Annex 2.14.** List of birds, which were observed at the time of lake monitoring, is presented in **Annex 2.15**.

a) The saprobic index (quotient) for Tulsi Lake, Vihar Lake & Powai Lake was calculated. It was found that the index for Tulsi Lake is 1.11. According to the standard table, provided by the author this index **suggests β meso-oligosaprobic** condition of lake water. The condition indicates the presence of slight organic load in the lake water. Total number of plankton genera recorded in Tulsi Lake is 15, with *Microsystis sp.* from blue green algae (Cyanophyceae) as a dominant genus. Though the Microcystis bloom was seen the stage may not remain for a longer period, since the saprobic index for the lake showed low organic load. The slight organic load leading to the microcystis bloom is probably because of the nutrients accumulated from the catchment after the rainy season.

b) The saprobic index (quotient) for Vihar Lake was 1.02. This index suggests β **meso-oligosaprobic** condition of lake water, which is similar to that of Tulsi Lake. However the total number of plankton genera recorded in this lake water are 12 with *Melosira* & *Nitzchia* (Diatoms) as the dominant genera. **These genera indicate more pollution than Tulsi lake.** This may be because of the polluting factors like the cattle washing, cloth washing, and local people using the lake water for variety of purposes, which are the polluting factors in the catchment of the lake.

c) The saprobic index (quotient) for Powai Lake was 0.83. This indicates β **mesosaprobic** condition of lake water suggesting more organic load in the lake water. The total number of plankton genera present in this lake is 11 with *Melosira* & *Nitzchia* as the dominant genera. There was a wide gap in the population of these species and other organisms observed in the lake water.

d) The number of species recorded in Tulsi & Vihar Lake were 15 & 12 respectively. These two lakes show slight differences in the distribution of population of the recorded genera. This indicates that the pollution load in these two-lake water was comparatively less. *Melosira, Nitzchia* & *Microsystis* were found to be the dominant genera in these lakes. According to Palmer's (1969) list of pollution tolerant genera of algae, *Nitzchia* having the highest order of pollution tolerance, followed by *Melosira* & *Microsystis.* Their order of pollution tolerance, according to Palmer (1969) is,

Nitzchia > *Melosira* > *Microsystis*

In Tulsi Lake, *Microsystis was* the dominant genus. This genus is the least pollution tolerant genus in the above sequence, while *Nitzchia* & *Melosira* are more pollution tolerant which are recorded as dominant genera in Powai & Vihar Lakes. However their population in Powai & Vihar is different. In case of Vihar Lake, the other genera are also present along with these two. While in case of Powai, the gap in distribution of population is much wide.

Following **Table 4.5** shows the saprobic index, species diversity and dominant genera of the plankton.

Table 4.5 Saprobic Index, Species Diversity of Plankton

Lake	Saprobic Quotient (Average)	No. of species recorded	Dominant species
Tulsi Lake	1.11	15	*Microsystis* (1)
Vihar Lake	1.02	12	*Melosira, Nitzchia*
Powai Lake	0.83	11	*Melosira* (1), *Nitzchia* (3)

According to Patrick R. (1973), in natural or healthy streams, algal flora was represented by high number of species, most of them with relatively small populations. The effect of pollution was on species diversity and to cause a greater unevenness in the size of the population. The organic pollution load on the lakes had resulted in the species composition variations with dominance of algal community in Tulsi lake to other dominated by diatoms.

This shows that the three lakes are in the following order of organic load, Powai > Vihar > Tulsi

SECTION 4.5 TERRESTRIAL ECOSYSTEM

4.5.1 Vegetation Mapping

Vegetation mapping exercise was carried out in core, buffer and disturbed zones and then compared with each other. The objective was to study impacts of human activities on park ecology and to provide a management plan to control any negative impacts. One of the objectives was to also define bio-indicators, which can be monitored periodically to assess forest health.

SGNP is one of the best examples of forest ecosystem where different types of vegetation is seen. Proximity to the seacoast, many watercourses and favorable geological factors provide conditions for diverse plant communities. The fresh water lakes and tidal creeks help to diversify the vegetation. Details of the vegetation types and list of flora are presented in **Chapter 3.**

In our study, an approach based upon floristics i.e. plant species composition is adopted. Vegetation is an expression of factors such as soil, geology and climate acting collectively on plant community. Forest departments frequently use an assessment of species composition to indicate site potential and to help in selecting species for plantation.

4.5.1.1 Methodology

The main objectives of the study included determination of typical plant community composition in specific Park areas such as core zone, buffer zone, and disturbed zone, recording variation / alteration in plant community composition in these zones and assessing the role of natural and / or human agencies in causing the observed differences in plant communities within these zones. Vegetation study was conducted for summer and post monsoon season.

A preliminary survey was undertaken in the entire SGNP, including the Northern Nagla block, for selection of sites for detailed study of the vegetation. The visits were conducted along with forest guards and officials to get first hand input on status of the area. Representative sites were selected on the basis of land use, vegetation cover and slope features.

Refer Map presented in **Annex 2.2** for vegetation study locations. Description of the sites selected is given below in **Table 4.6**

Table 4.6 Sites for Vegetation Studies

Area	Location	Zone	Terrain
Tulsi lake	West of the Tulsi lake near loghut	Core Zone	Hilly Terrain
Vihar Lake	West of Vihar lake, near Tulsi main pipe	Slightly disturbed buffer zone	Plain Terrain
Chenna East	S.No. 89, near revenue village	Buffer zone	Plain terrain
Sasunavghar	No. 1115, Nagla block,	Buffer zone	Slightly hilly terrain
Yeur (West) forest	South west of Yeur village, No. 1141.	Core Zone	Slightly hilly terrain
Gautam Nagar	87/B (Aakurli), Near Malad side,	Buffer zone-encroachment area	Plain terrain
Tulsi Shoreline	East of the Tulsi	Core zone	Plain terrain

In summer season, quadrat method was followed whereas in post monsoon Transect method was used. Both the methods are detailed below.

A) ***Quadrat Method*** - Three quadrats of 100-sq. m. each were laid at each of these sites and all plants with main trunk diameter greater than 15cm at breast height (i.e. DBH - 1.3 m from ground) were recorded. The species of plants were identified at the site itself, or after bringing leafy twigs to the laboratory and referring the specimen to the standard publication for the purpose **[see Reference No.7 Annex 4(B)]**. **Photo 15, 16** (Annex 8A) shows fieldwork on vegetation mapping in progress.

The species variety and their numbers were recorded, in each of the quadrats. Approximate height of each tree/shrub was also noted. The data was analyzed for quantitative characters like Frequency, Abundance, Density, Basal area, etc., on the basis of which Importance Value Index (IVI) of each of the species at each of the sites, was calculated.

A brief description and equations for calculation of these parameters are given in **Annex 2.16**. The Annex gives the plant species and the results of the vegetation mapping exercise. Economic importance of the plant species recorded are also documented against the various plant species in **Annex 2.16.**

Community Coefficient : Community Coefficient (CC) is calculated on the basis of frequencies of species in different plant communities, using the formula :

$$CC = \frac{2\,w \times 100}{a + b}$$

Where, **w** is the sum of the lowest frequencies from communities A and B being compared

a + b is the sum of frequencies of the communities A and B.

Higher CC indicates high level of similarity between the communities being compared, lower CC points to high level of dissimilarity, and hence difference between the two communities.

Sometimes it becomes necessary to compare plant communities in two places within the same bio-climatic zone. Since all the natural climatic factors are the same, we may expect the same nature and community composition, but differences in composition do occur, due to locally operating factors, e.g., differences in topography, slope gradient, soil thickness etc. as also locally operating biotic factors. Intensity of this operating factor gets reflected in the differences in community composition of the two communities in question. This level of difference is brought out by the value of the community coefficient (CC).

In the present study, a climax (ideal) community (Tulsi catchment) is compared with each of the other communities (Vihar, Yeur etc.) , for assessing the level or magnitude of deterioration that has taken place as a result of operative biotic (human) factors.

B) ***Transect Method***

- Aim of transect study is to bring out arrangement of plant species with reference to each other and along a gradient of land. The latter is important across slopes of hills and across land-water interface, where one plant community type gives way to another one. It also focuses on distances between plants.
- In the present case, transect type studied is the 'Profile' Transect. It gives a side view of plant community as seen by an observer from a side, accounting for distances between neighboring plants, their heights, crown sizes, as well as their dispersion on the landscape.

- The same sites used in the quadrat method were selected for this study. In each representative area, one transect of suitable length was laid across the slope gradient in case of hills and at right angles to land water interface on banks of lakes. Length of the transect line was determined according to

vegetation type, ensuring that the representative nature of the plant community was covered.

- Trees and shrubs touching the transect line were marked from end to end on the line, noting distances of the same from starting (i.e. 0) point. Approximate height of each plant was recorded and its canopy shape was noted.

- The data was presented, using graph papers, as a drawing wherein 1 cm in the profile diagram represented 1 meter on ground, both for distance and tree height. Approximate lay of land was also represented on paper, though not on scale. All the transect diagrams are presented in **Annex 2.17 (a to f).**

- Standard Phytosociological methods of vegetation analysis, as derived by a pioneer scientist in this field, Prof. J. Braiin Blanquet (Pflanzensociologic, 1920), have been used, with subsequent modifications by the more recent workers in the field – Prof. Richards, Prof R. Misra (BHU Varanasi) etc.

4.5.1.2 Results and Discussion

(A) *Quadrat Method* *(Refer Annex 2.16)*

- At some sites soil was red and at some places it was black. Earthworm activity was observed in black soil. The soil layers observed were thin or scanty between 2 and 5 cm thickness to deep ones, depending on their location at slopes or valley bottom. Soil sample from individual site was collected for analysis; details of soil sampling and analysis are given later in this Chapter.

- Soil surface was found to be covered with leaf litter, (between 0 to 100 %) in the study areas. The thickness varied between 0 and 15 cm.

- Choice of *Tulsi lake* catchment area as the control one (i.e. a developed, mature plant community, with a typical biome of the bio-geographical zone) is justified. The plant community is composed of a number tree species that are tall, with high density value. Teak along with Bamboo and Morinda form the climax forest. These tree species have high IVI and hence dominate the community. **Photo 17 and 18** in Annex 4A shows vegetation at Tulsi Lake catchment.

- The same species do not have similar dominance (IVIs) in any other communities studied in National Park. Near *Vihar lake*, where disturbance is of a high level, three low saturated species – bushy Carissa, shrubby Holarrhena and small tree Streblus – dominate instead of the typical tree species of the tropical moist deciduous forest that is the natural forest type of the region.

- A small number of species with high frequency values at *Tulsi lake* site, indicate a more homogenous vegetation, while large number of species with low frequency values at encroached site, show heterogeneous vegetation.

- *At Sasunavghar* site, *Schleichera oleosa, Mangiffera indica* are found dominant whereas in case of Yeur site *Tectona* and *Wrightria* were dominant. **Photo 19** shows deciduous nature of Yeur Forests. In **Photo 20** high density of Yeur Forests is indicated by many examples of epiphytes, parasites and commensals. When a plant community is dense, with few vacant spaces on ground, but other conditions are adequate (esp. water), nature encourages growth of plants that can grow without touching the ground (epiphytes) or with minimal spread on ground and no separate allocation of space, till the plant reaches the top canopy and spreads foliage in order to absorb sunlight with minimal expenditure of energy (eg. Lianaceous climbers)

- *Chenna* an agricultural area within the park also shows different dominants, though they are small and big trees. In Chenna, *Acasia catechu* is recorded as dominant. **Photo 21** shows the dense cover of forest in Chenna. **Photo 22** shows Paddy field interrupted by mango, palm and other trees. Hills covered with dense vegetation form the background to this remote part of the National Park area.

- The picture gets completely fudged in the *encroached part* of the park, where diversity of species is more typical of disturbed areas in many ecosystems. High diversity however, is not matched by ground cover, which is almost 100 points lower than at Tulsi lake. This shows that the plants are small, immature (or stunted). None of the species clearly dominates the plant community, wherein, Carrisa shrubs have the highest IVI and Zizypus, a species of semi - arid zones has also high IVI.

- A climax community permits few invaders, hence it remains stable. A barren area on the other hand, permits all and sundry disseminates to invade from the neighbourhood. It also receives seeds from other areas through the agency of biotic invaders. Hence the variety of species in a disturbed community is large, but their stability (growth and establishment) is low. Heirarchy of dominance by species (IVI of species) is not clearly defined. Spiny plants that repel biota (humans and grazing animals) survive in good numbers, in such places.

(B) Community Coefficient

The values of CC obtained by comparing Tulsi catchment area plant community with each of the other area communities are as follows –

No.	Control site / study area	Community Coefficient
1	Tulsi catchment and Vihar catchment	9.99
2	Tulsi and Sasunavghar	9.99
3	Tulsi catchment and Chenna	9.75
4	Tulsi and Yeur	8.51
5	Tulsi and Gautam Nagar	6.56

- In the entire Park area, the climate is the same and soils are also similar and hence one would expect uniform plant community composition. Only the level of local operating factors may cause changes in the community composition. Since Tulsi lake catchment is well conserved, all other sites are compared with it for community composition.

- It is found that Tulsi and Vihar catchments and Tulsi and Sasunavghar are similar in plant community composition, while Yeur plant community is somewhat dissimilar.

- Although, the number of species is higher in Gautam Nagar plant community, it is much different than in climax community at Tulsi. Thus the CC values were lowest at 6.56, studied during the present work. It is known that the Gautam Nagar area is recently vacated of its encroachment and the plant community consists of weeds and annuals, some cultivated plants, etc. As a matter of fact, whatever similarity is found, is probably due to some cultivation of forest tree species in the area.

(C) Transect Method

All the transect diagrams are presented in **Annex 2.17 (a to f).** Transect 1 to 6 are given as Profile diagrams, showing the following characters of vegetation.

- Transect 1 – Length 65 meters, along slope starting from Log cabin hill to Tulsi lake water level. Tall trees (teak, Mallotus, Albizzia, Ficus, etc) reaching almost 20 meters in height, form the top canopy forest, with fairly closed forest. Herbaceous plants occupy some distance on both sides of the road. This community represents the vegetation that is typical of the climatic climax community (i.e. mixed deciduous forest) consisting of dense growth of evergreens (*Mallotus, Ficus, Morinda*, etc.) and deciduous (*Tectona, Butea*, etc.) elements.

- *Transect 2* – Length 40 meters on rocky shoreline of Tulsi lake. Most of the area is rocky or shallow soil covered with grass and herbaceous plants. A tall *Bombax* tree shows the beginning of the forest. It represents open, grassy type of vegetation along the banks of the lake.

- *Transect 3* – Length 46 meters. This is a fairly well wooded part in Vihar catchment area. Trees form a tall, closed canopy, with evergreens like *Morind, Kadamb, Karanj*, etc., while an odd deciduous Palas is also present in second stratum (layer) of the forest. Herbaceous plants are present along road and in the shallow bed of the catchment streams.

- *Transect 4* - Length 50 meters on hill slope of Sasunavghar. This hill shows an open forest with some relatively small trees of 8 to 10 meters height and a large number of stunted (1 –2 meter tall) trees of Randia, Morinda, etc. Presence of *Ficus hispida*, a secondary invader in the forest, is an indication of disturbance of the forest community. Herbaceous plants and grasses also abundant in exposed areas.

- *Transect 5* – Length 32 meters. Yeur (west) forest again is an example of closed canopy forest of tall (15 meters and above) and medium (8 – 15 meters) trees where canopies touch and permit little sunlight to fall through. Near the road herbaceous plants prevail in opened up areas, bamboos are also common. Some of the trees (*Morinda, Adina, Randia*) are hardly 1 – 2 meters in height showing somewhat disturbed nature of the community.

- *Transect 6* - Length 52 meters. The disturbed area of the site (Gautam nagar) that has been recently vacated of encroachment shows a large variety herbs, shrubs and small trees forming an open plant community. A few tall teak trees are the only exception. A large number of Zizyphus trees and small Terminalias show heavy degradation of the plant community, that is attempted to be restored by forest plantations of teak, Kadamb, Adina, etc.

(D) Overall Conclusion:

- Tulsi forest (core zone) is an example of ideal mixed moist deciduous forest. Whereas, Vihar catchment and Sasunavghar forest (Buffer Zone) are slightly degraded but show much similarity with Tulsi Forest. However, presence of *Ficus hispida*, a secondary invader in the Sasunavghar forest, is an indication of disturbance of the forest community. Ground of Tulsi Forest is also covered by a dense mat (5 to 15 cm) of litter, indicating good health of forest.

- In Yeur forest (Core Zone) some of the trees (*Morinda, Adina, Randia*) are hardly 1 – 2 meters in height showing somewhat disturbed nature of the community.

- Gautam nagar (area near encroachment – Disturbed Area) shows marked difference in plant community when compared to other sites. A large number of Zizyphus trees and small Terminalias show heavy degradation of the plant community, that is attempted to be restored by forest plantations of teak, Kadamb, Adina, etc. Open ground here is occupied by abundant grass, the pioneer invaders of disturbed areas.

4.5.2 SOILS in SGNP

Soils are complex mixtures of different sized rock particles, humus, air, water and dissolved minerals. They represent a fundamental component of terrestrial ecosystem

and as such have a major role in determining the plant and animal communities that inhabit them. Soil is a basic component of the land environment and assumes an important role in its management. Any degradation of soil would affect the delicate web of terrestrial life. Soil with many other factors in the environment decides the drainage pattern, type of vegetation, agriculture etc.

4.5.2.1 Soil sampling

Composite soil samples were collected and analysed for physical and chemical parameters. Soil quality was analysed at the same six locations where vegetation mapping was carried out:

- Tulsi Near Loghut
- Near Vihar (No. 19)
- Sasupada (S.No. 1115)
- Chenna East (S.No.89)
- Yeur West (S.No. 1143)
- Encroachment - Aakurli (87/B)

Soil quality monitoring results are summarized in tabular form in **Annex 2.18.** See **Map in Annex 2.2** for soil sampling locations.

4.5.2.2 Data Evaluation

- Soil pH varies between 5.5 and 7.8 indicating majority samples as neutral in nature, however sample collected from encroachment area - Aakurli (87/B) site is slightly acidic in nature (5.5pH).
- Conductivity is a measure of current-carrying capacity, thus gives an idea of soluble salts present in the soil. Electrical conductivity ranges between 25.0 to 805.0 μmhos; highest recorded at Chenna east and Sasunavaghar side in summer season.
- The major soil nutrients such as N, P, K are present in low amounts.
- Organic matter value ranges between 0.52 and 9.0 %: highest at Tulsi site in post monsoon period, a result of decaying litter and vigour of the mineral cycle.
- Lead ranged between 0.434 and 7.1; highest recorded at Chenna in post monsoon.

A National Park is a protected area in which all biota is protected and harvesting of any component of the ecosystem is prohibited. Stressing economic importance of constituent species would give a wrong signal to those interested in exploiting the Park for material benefits. Experience has shown that even a single authorized harvesting exercise would attract ten unauthorized ones. Hence, economic or otherwise usage plants are not cited in this report, though a large proportion of the species found here are known to yield useful products.

SECTION 4.6 LANDUSE STUDY

4.6.1 Introduction

Protecting the uniqueness of the park is an important consideration for Government of Maharashtra and so is the need to maintain the public resource of water and the benefits of a green zone within the city.

Increasing urbanization in the vicinity of the park has resulted in high biotic pressure, in terms of extent, structure, composition and wildlife habitat conditions within and in the immediate surroundings of the park. These concerns are further compounded by illegal encroachment of parkland by hutment dwellers, resulting in reduction of the protected area under SGNP. It is therefore important to determine the landuse pattern within the park area and to repeat the exercise every other year to keep track of the changes in land use.

4.6.2 Methodology

Data used for the study –

a) IRS 1-C LISS III image dated 10 Feb 2000
b) IRS 1-C PAN images of the study area (2 scenes) dated 11 Mar and 20 Mar 2000
c) The relevant parts of 1:50000 toposheets 47 A/15 and A/16 acquired from SGNP Office
d) 1:50000 blueprint of the classification done by SAC in 1995 as part of their report (Acquired from SGNP office)
e) Catchment area Maps provided by MCGB for Tulsi, Powai and Vihar Lakes.

The map segments were mosaic and then the LISS-III and PAN data were geocoded to the map in Polyconic projection. Once the LISS and PAN data were in the same coordinate system they were merged so as to make full use of the multi-spectral resolution of the LISS image and the spatial resolution of the PAN image. The merged satellite picture is given in **Annex 2.19.**

The transformed image was then used as the basis for the unsupervised classification of the image into six classes (the optimal number of classes was arrived at after several iterations where the scatter plots of the data were studied to evaluate correlation). Once it was clearly established that six classes could be identified with a reasonably high degree of certainty, training sets were selected, based on a study of the top sheet and the interpretation of the satellite data, for selecting the various

classes needed to identify the changes vis-à-vis the previous study by SAC, Ahmedabad.

The classification map generated by the SAC study was digitized and referenced to the merged satellite image so that the previously identified classes could be compared with the present ground realities to assess the temporal change in status.

Supervised Classification of the study area, on **EASI/PACE software (Version 6.3)**, was carried out on the satellite image for extraction of land use pattern. The classification algorithm used was the Maximum Likelihood Classifier. Following six classes were categorised for the classification.

1. Forest area: - Reserved forest, mixed forest, Dense and low dense forest etc.
2. Water bodies: - creek, Lakes, tanks etc.
3. Agricultural land: - Agriculture, Plantations, Vegetation, Blank land etc.
4. Settlement: - Buildings, Settlements, Hutment's, Built-up area etc.
5. Mangroves: - Mangroves.
6. Encroachment: - Hutment's, Settlements, Agricultural land, Damage due to revenue village.

The methodology flow diagram of the study is given in **Annex 2.20.**

The classification was carried out for SGNP and the water bodies in and around the park, including Tulsi, Vihar and Powai lakes. The percent landuse classification for the catchment areas of these lakes was computed from the pixel distribution. Lake landuse classification is given in **Chapter 3.**

The classification done was verified during a visit to the site by the interpreting team for ground truth collection to check accuracy of the classification assessment. The land-use map was then regenerated with the ground truth inputs and used to evaluate the change in land use pattern and encroachment status. The sites visited during ground thruthing exercise are given below:

Places Visited During Ground Truth Collection

NAME OF PLACES	DESCRIPTION
1. Chenna East Village	A Revenue village, the extent is nearly same as before.
2.Chenna West Village	A Revenue village, the extent is nearly same as before.
3. Yeur Village	A Revenue village, the extent is nearly same as before. Mainly huts.
4. Malad	Encroachments can be observed along the boundary of the National Park near Malad (**See photo No. 36**). No new quarrying was visible. Previous quarries are being a forested.

5. Nagla	Agricultural encroachment has increased.
6. Kanheri Caves	Ancient caves with archaeological value
7. Tulsi And Vihar Lake	Water level was low- Pre monsoon level.
9. Mulund Side Of Park	Encroached area can be easily observed along t boundary of the National Park near Mulund.

4.6.3 RESULTS AND DISCUSSIONS

The supervised classification based on the maximum likelihood classifier, combined with visual analysis, gave the following results:

1. Forest — In Sanjay Gandhi National Park the trees are mostly mixed types. The forest area on the satellite image is exhibited by characteristic spectral signature owing high reflectance in IR region. Photograph showing southern moist mixed deciduous forest at Yeur side is given in **Photo No. 19** in Annex 4A.

2. Water bodies — Water bodies with very low reflectance appears in blue or black color on the satellite images (FCC). (Shallow waters with high reflectance exhibit Blue colour, while deep water bodies with very low reflectance exhibit black tone on the FCC). Aquatic weeds are prominent in Powai lake.

3. Agricultural land — Agricultural land including cultivated land, plantations reflect a characteristic spectral signature associated with a regular pattern and shape on FCC. Agricultural land in Nagla block is shown in **Photo 23** in Annex 4A.

4. Settlements — Settlements including buildings and built-up area which reflect a dull to bright spectral signature depending upon density and reflectance of the material associated with conspicuous man-made linear features like roads etc on the FCC satellite image.

5. Mangroves — Mangroves with high reflectance in IR region exhibit characteristic spectral signature in association with water bodies and marshy lands.

6. Encroachments — Encroachments are primarily hutments, which are covered with either asbestos sheets or polythene sheets exhibit a characteristic pattern along the boundaries of the park.

7. Shoreline Vegetation — Shoreline vegetation are characteristic along the shorelines of the water bodies in the area. These exhibit a characteristic signature associated with the water bodies.

8. Aquatic Vegetation	These are floating aquatic plants and weeds, with a very high reflectance in the IR range and are associated with water bodies. These include species like water hyacinth etc.

Training sites for the above classes were selected and classified. For eliminating the unwanted noise/interference a 5 X 5 median filter was used.

Updated land use classification Map of the Sanjay Gandhi National Park is given in **Annex 2.21**. Pie chart of the landuse classification of SGNP is given in **Annex 2.22.** It can be seen that about 85.29% land in under forests, 2.21% under water bodies, 11.34% under urban / settlements (including settlements in revenue villages, roads etc.) and 1.16% under agriculture.

From the study of the satellite image the encroachments were observed along the boundary of SGNP. There has been a substantial increase in the area under encroachment vis-a-vis the study carried out earlier in **1995 by Space Application Center (SAC), Ahmedabad**. **After that an extensive demolition work was undertaken as per High Court's order and approximately 80% of encroachment area has been demolished by Forest Department.**

Section 4.7 SOCIO- ECONOMY

The tribal settlements at Yeur, Nagla and Chenna are traditional but the settlements in and around the Krishnagiri Upwan and Kanheri Caves are relatively recent, and may not have existed prior to 1950. According to Pada dwellers they are there since last 50 years. (ECONET, 1997).

There are 10 padas situated inside the KUP range namely *Dam, Tala, Malyacha, Chinchpada, Chuna, Nava etc.* Approximately 50% of the people of these padas are tribals, while the rest of them are non- tribals. Warli is the main community in these and others are Mahadev Koli, Malhar Kolis and Thakurs etc.

There are average 30 huts present in each settlement. There is no proper school facility. Literacy rate is very poor. Some social groups are running *'Aanganwadi'* for children of tribals in the park area. They fulfill their water need by water sources like waterholes, borewells and openwells present in Park area. Open defecation is common practice.

Main source of income is employment in nearby areas outside the park. Some of the pada dwellers are working in forest department as labours and field staff.

KEY FINDINGS

Air and Noise

- 24-hr values at various locations in the park area for the whole year varied between 46 $\mu g/m^3$ to 300 $\mu g / m^3$. High concentrations were observed at SGNP gate at Borivali and at Yeur Village. The high values at SGNP gate can be attributed to the heavy traffic on western express highway located very close to SGNP (Borivali) gate. Lowest values were observed near Tulsi Lake area.
- SO_2, HC, and CO levels were well below the standards at all locations in the park.
- NOx levels ranged between 11.67$\mu g / m^3$ to 37.2 $\mu g / m^3$. The highest levels were found at SGNP (Borivali) gate and are slightly higher than the standard of 30 $\mu g/m^3$. This also can be attributed to heavy vehicle density on adjacent Western Express Highway.
- There are no major noise emitting sources present in park. Noise levels in SGNP area varied between 30 to 65 dB (A). Nighttime exceedances were observed mainly at Yeur Village. These noise level exceedances can be attributed mainly to vehicular noise.

Surface and Ground Water

- Water quality of Dahisar river at source at outlet were within the standards for chemical parameters as per IS 10500. Chemical parameters were well within the IS limits but water is not potable without treatment as it has high coliform counts.
- Outlet of Chenna river had high TDS, hardness and chlorides- this is because of tidal effect of bassein creek on the Chenna outlet. Chemical parameters were well within the IS limits but water is not potable without treatment as it has high coliform counts.
- In Bassein creek most of the parameters were found exceeding the limits. Dissolved Oxygen was recorded as 3 mg/lit, which is not sufficient for sustaining aquatic life.
- Groundwater at most places are within the standards but at some locations microbial count was higher such as Gautam nagar, Mafco, Bambuhut and Tumnipada. At these places water must be treated prior to use as drinking water.

Lake Ecosystem

- Plankton analysis indicated β meso-oligosaprobic, β meso-oligosaprobic, β mesosaprobic state of Tulsi, Vihar and Powai lakes respectively. This indicates that the pollution load in Tulsi and Vihar was comparatively less than Powai.
- In Tulsi and Vihar lake typical 'Clinograde curve' was observed for **Dissolved oxygen** and temperature profile. For both these lakes, DO values were quite satisfactory (highest around 8.8mg/lit for Vihar and 8.9 mg/lit for Tulsi lake). Powai was found to have highest productivity indicating higher pollution levels.

- In Tulsi lake very few **macrophytes** were observed, this indicates good catchment and water conditions of Tulsi lake. In Vihar lake, macrophyte vegetation was less compared to the area of the lake. Variety of human activities in Powai catchment are responsible for increasing water hyacinth on all sides in the lake.
- On Tulsi and Vihar shoreline, a large number and variety of **macro-invertebrates** were observed. Large number of shells was observed in littoral vegetation of Powai lake. This indicated good conditions of shoreline environment in Tulsi and Vihar lake and a considerably degraded shoreline for Powai lake.
- **Vihar Lake water** is of good quality, except for slightly increased levels of Iron and Manganese. The water was colorless, odorless and showed slightly high turbidity. Microbiological contamination was observed at some locations due to human interference (washing, bathing etc.) near darga boundary of lake.
- **Tulsi Lake water** is of good quality and no microbiological contamination was recorded. In fact, Tulsi lake and its catchment can be considered as a control for future studies on lakes in this region.
- **Powai Lake water** is of poor quality, very turbid, greenish color due to large number of Phytoplankton. Higher BOD and COD values indicate contamination by organic matter. High MPN values were observed in all samples.
- Bottom sediments from Tulsi and Vihar lake indicated no significant levels of heavy metals. Heavy metals levels in Powai lake sediments were observed to be higher than these two lakes.
- No **riparian vegetation** was seen in all the three lakes.

Terrestrial Ecosystem

- Tulsi forest (core zone) is an ideal mixed moist deciduous forest. Whereas, Vihar catchment and Sasunavghar forest (Buffer Zone) are slightly degraded but shows much similarity with Tulsi Forest. However, presence of *Ficus hispida*, a secondary invader in the Sasunavghar forest, is an indication of disturbance of the forest community.

- In Yeur forest (Core Zone) some of the trees (*Morinda*, *Adina*, *Randia*) are hardly 1 – 2 meters in height showing somewhat disturbed nature of the community.

- Gautam Nagar (area near encroachment – Disturbed Area) shows demarcated difference in plant community when compared to other sites. A large number of Zizyphus trees and small Terminalias show heavy degradation of the plant community, that is attempted to be restored by forest plantations of teak, Kadamb, Adina, etc.

- Soil pH varies between 5.5 and 7.8 indicating major samples as neutral in nature. The major soil nutrients such as N, P, K are present in low amounts. Heavy metal content was found to be very low.

SGNP Landuse Study

- As per satellite imagery studies (IRS image dates February 2000), landuse classification of SGNP shows about 85.79% land in under forests, 2.21% under water bodies, 11.34% under urban / settlements and 1.16% under agriculture.

- There has been a substantial increase in the area under encroachment vis-a-vis the study carried out earlier in 1995 by Space Application Center (SAC), Ahmedabad. Extensive demolition work was undertaken by Forest Department in the last 2 years, as per High Court's order and approximately 80% of encroachment area has been demolished.

Chapter 5 LEGAL ASPECTS AND ADMINISTRATIVE FRAMEWORK

5.1 Introduction

Although India is the seventh largest country in the world, only 1.8% of the world's forest is found here. As per the state of forests report of the Forest Survey of India (FSI 1999), the forest cover of the country is 63.73 million ha constituting 19.39% of the geographic area of the country, out of which 37.74 million ha (11.48%) is dense forest, 25.50 million ha (7.76%) open forest and 0.49 million ha (0.15%) mangroves. Out of India's population of about one billion, 360 million live in or around the forest area, exerting tremendous pressure on limited forest resources. SGNP too is located in the urban area of Mumbai City and is subjected such pressures.

The existing expanse of 103.29 Sq. Km of SGNP has been formed over the years by land acquisitions by the Government. Park management activities have to be geared towards protection from outside disturbances and also enhancement of the park ecology. Various forest related Acts and Rules have been enacted by Government of India and Maharashtra for preservation and protection of forests in India. The Park management has also prepared Forest Management Plan for managing various activities in the park.

5.2 Park History

Before 1950 the park was managed by the KHOTS and was subjected to widespread abuse and degradation. The management of the park was transferred to the Department of Parks and Gardens in 1950 and thereafter to the State Department of Forests in 1960. The chronology of events is given below in **Table 5.1**:

Table 5.1 – Important Highlights on History of SGNP

Period	Description
Before 1808	Forests of Yeur and Nagla constituted state property under the maratha regime.
1808	British Govt. took over the control of the forests.
1845	Forest department came into existence
1860	Forest area of Vehar lake catchment was acquired by BMC.
1883	Forest area of Tulsi lake catchment was acquired by BMC.
1927	National Park was first time notified under the Indian Forest Act 1927
1968/ 69	Decision to create Borivali National Park covering of area 68.27sq.km.

Period	Description
1969	Different areas were brought together under one management and special sub- division was created.
1977	The management of the National Park transferred to the Maharashtra State Forest Development Corporation.
1981	The decision to rename Borivali National Park as Sanjay Gandhi National Park
1982	The State Govt. added an area of 19.988 sq.km to the original area.
1988	The management of the National Park transferred back to the forest department.
1995	The State Govt. of Maharashtra finally declared this National Park as per the provisions of the Wildlife (Protection) Act 1972, amended 1991.

5.3 Legal Provisions

The major Acts and Rules under the provisions of which SGNP is managed are:

- The Indian Forest Act, 1927
- The Wildlife (Protection) Act, 1972
- The Forest (Conservation) Act, 1980
- Maharashtra Private Forests (Acquisition) Act, 1975
- Maharashtra Felling of Trees (Regulation) Act, 1964

The major provisions of these acts are given below:

5.3.1 The Indian Forest Act, 1927 *(as modified upto October 31, 1983)*

The Indian Forest Act, 1927 was not substantially different than the 1878 Act and it remains the legislative basis for state forest management today. Initially forests were placed under the State List on which state legislatures have a primary right to make laws. In 1976, the Indian Forest Act was added to the Concurrent List of the Constitution of India, giving the Centre and States shared responsibility and control over forest matters. Government of India does have the power to legislate on forestry issues, but only after consulting the States. The responsibility of administering the forests lies primarily with the state government.

Major provisions in this Act for forest protection and preservation are:

a. Acts Prohibited in reserved and protected forests (except by permission in writing from forest officer)
   - Setting, kindling or carrying any fire
   - Trespassing and pasturing of cattle

- Felling, tapping, burning or in any way damaging of any tree
- Quarrying of Stone, lime/charcoal burning or carrying out any manufacturing
- Taking out any forest produce
- Clearing or breaking up land for cultivation or any other purpose
- Hunting, shooting, fishing, poisoning water, setting traps or snares

b. The forest officer can sieze equipment/cattle etc. used to commit a forest-offence such as removing forest produce, cattle trespassing etc.

c. State Government may constitute any forest land or waste land which is the property of Government , or over which the Government has proprietory rights a reserved forest or protected forest.

d. State Government may invest Forest Officers with certain powers such as :
   - Power to enter upon any land to survey, demarcate and make maps.
   - Power to issue search warrants under the Code of Criminal Procedure, 1973.
   - Power to hold an inquiry into forest offences and receive and record evidences.

5.3.2 The Wild Life (Protection) Act, 1972

After independence, the National Forest Policy of 1952 laid down that the claims of the communities living in and around the forests should not override national interests. The destruction of forests for construction of roads, irrigation and hydroelectric projects, industries etc. was justified in the name of national interest. Increased depletion of forests and wild life living in them created a stir in the society and as a result the Wildlife (Protection) Act was enacted in 1972.

Major provisions in this Act for forest protection and preservation are:

a. No person shall hunt (except in permitted cases) any wild animal specified in the schedules of the Act except as allowed by the Act. (Hunting includes killing, injuring, capturing, trapping and attempting to do so. It also includes damaging or moving the eggs of birds, reptiles etc.)
b. No person shall willfully pick, uproot, damage, destroy, acquire or collect any specified plant from any forest land and any area specified, by notification, by the Central Government.
c. Posses, sell, offer for sale, or transfer by way of gift or otherwise, or transport any specified plant, whether alive or part.
d. The state Government may, by notification, declare its intention to constitute any area other than an area comprised within any reserved forest or the territorial waters as a sanctuary if it considers that such area is of adequate ecological , faunal, floral, geo-morphological, natural or zoological significance, for the of protecting, propagating or developing wild life or its environment.

e. No alteration of the boundaries of a National Park shall be made except on a resolution passed by the Legislature of the State.
f. No person shall destroy, exploit or remove any wild life from a National Park or destroy or damage the habitat of any wild animal or deprive any wild animal of its habitat within such National Park except under and in accordance with a permit granted by a State Government.
g. No grazing shall be permitted in a National Park and no cattle shall be allowed to enter therein except where such livestock is used as a vehicle by a person authorized to enter such National Park.

5.3.3 MAHARASHTRA PRIVATE FORESTS (ACQUISITION) ACT, 1975 (ACT NO. 29 OF 1975)[1]

a. All private forests in the State shall stand acquired and vest, free from all encumbrances, in and shall be deemed to be the property of the State Government, and all rights, title and interest of the owner or any person other than the Government subsisting in any of the such forest on said day shall be deemed to be have been extinguished.
b. All private forests vested in the State Government under sub-section (1) shall be deemed to be reserved forests within the meaning of the Forest Act.

5.3.4 OTHER LAWS RELATED TO TREES/FAUNA APPLICABLE OUTSIDE THE NATIONAL PARK AREA

A. MAHARASHTRA FELLING OF TREES (REGULATION) ACT, 1964 (ACT NO. 34 OF 1964)

Notwithstanding any custom, usage, or law for the time being in force, or the degree of a Court , or anything contained in any instrument to the contrary, no person shall fell any tree (Tree as defined in the schedule) or cause such tree to be felled in any land, whether of his ownership or otherwise except with the previous permission in writing of a Tree Officer duly empowered by the State Government in that behalf.

B. MAHARASHTRA LAND REVENUE (REGULATION OF RIGHT TO TREES ETC.) RULES, 1967

No trees within thirty meters of the extreme edge of the bank of any water course, spring or tank or on any hilly and undulating ground with slopes and containing unculturable soil or a marginal land where economic production of field crops is not possible shall be cut, except with the previous permission of the Collector.

C. (REGULATION OF TRADE) ACT, 1969 (ACT NO. 57 OF 1969)

"Forest produce" means such forest produce as defined under the Indian Forest Act, 1927 (16 of 1927), as are specified in the Schedule appended in this Act, and the State Government by notification in the official Gazette, add to or modify the schedule in the public interest, and the provision of sub-section (3) of Sec. 19 in so far as they relate to laying before, or modification, as they apply in relation to any rule made under that section should apply in relation to such notification.

5.3.5 Legal Action Initiated by the Bombay Environmental Action Group (BEAG)

A writ petition was filed by BEAG in 1995, against the Conservator of Forests (SGNP), regarding illegal encroachments on lands belonging to SGNP. In December 1996 a landmark Supreme Court order was given in favour of a writ filed by Shri Godavarman Tirumulkpad regarding non-forest activities in forest land in North-Eastern State of India.

This order was taken into cognizance immediately by the Bombay High Court and an order was passed on May 7th, 1997. Salient features of this order are as follows:

1. The BMC is not to issue any permission under the BMC act in National Park Division area for any commercial or industrial activity. Similarly BMC is not to register any person under the Shops and Establishment Act within the boundaries of the National Park Division. Exception is made only in the case of public authorities.

2. The BMC is to cancel all sanctions and registrations and permissions granted within the park division. All structures having commercial establishments, schools etc within the park division is to be demolished within one year.

3. No permission to be granted by any authority for repair or reconstruction of structures within the National Park Division, except in the case of structures belonging to public authorities.

4. A survey of the inhabitant of the park is to be conducted within one month. Any person found to be in possession of a hut for which he himself does not have a valid photo pass must be evicted forthwith and the structure demolished. No transfer of photo pass pertaining to structures within the National Park Division is permitted.

5. All unoccupied huts structures found within the National Park Division after the survey are to be demolished, and the material used for the construction is to be confiscated so that same is not used to re-erect the structure.

6. Any person refusing to vacate the forest land under the provision of the Forest (Conservation) Act, 1980. Indian Forest Act, 1977 and the wildlife (Protection) Act 1972, must be evicted.

7. All persons whose names are found in electoral rolls prepared with the reference to 1st January 1995 or any date prior thereto shall be forthwith removed from the National Park and structures inhabited by them shall be demolished. All material be confiscated so that same is not used to re-erect the structure.

8. All the slum dwellers residing within the National Park whose names appear on the electoral rolls prepared with the reference to 1st January 1995 or any date prior to that shall be relocated to places outside the park boundaries by the State Government.

9. The State Government shall publish a notice in Marathi and Hindi Newspapers informing of its intention to demolish structures within the National Park.

10. The BSES and BMC are directed to disconnect all electric and water supply connection to hutments that will be demolished as per the above mentioned directions.

11. The Food and Civil supplies Department are directed not to issue further sanctioned to any more ration shops in the National Park Division. All shops presently functioning must be demolished within the year.

The High Court passed another order connected to BEAG writ on July 17, 1999. Salient features of this order are:

1. MAFCO factory located inside SGNP to be shifted within 2 years of order dated 28th April 1999.
2. State Govt. to construct boundary wall at strategic points in about 22 kms.
3. Dy. Conservator to ensure that that no fresh constructions are permitted in the area cleared of encroachments and any new encroachments to be evicted. No notice will be necessary and the Courts or Tribunals will not entertain proceedings in this behalf.
4. Govt. to ensure peaceful re-location of the encroachers.
5. Several other directives were given in this order related to appointing a committee to oversee peaceful relocation of encroachers and compensation to eligible encroachers.

5.4 Administrative Structure

5.4.1 Institutional Arrangements:

Department of Forests, Government of Maharashtra

The department is in charge of management, administration and conservation of wildlife in the state. An officer of the rank of Conservator of Forests looks after solely the wildlife and its conservation. Assistant Conservator of Forests in-charge of wildlife, supervises the other small sanctuaries in-charge of wildlife.

Sanjay Gandhi National Park Division

A Deputy Conservator of Forests, belonging to Department of Forests of Government of Maharashtra, looks after the scientific management and administration of the Park. The park has required infrastructure for training its staff in various wildlife management activities like Radio tracing, wildlife and health, forest fire management and drawing up inventory of different types of wildlife.

The Sanjay Gandhi National Park Division has three territorial ranges; each headed by a Range Forest Officer (RFO). The forest rounds and beats are in charge of foresters and forest guards respectively. The important team members in Park organization are listed below in **Table 5.2**:

Table 5.2 Administrative Structure in SGNP and SGNP Division

Sr. No.	Organization Member	Roles & Responsibilities	Total Number
1.	Conservator of Forests	Over all in-charge of SGNP Division which includes the SGNP and also adjoining forest area.	1
2.	Deputy Conservator of the Forest	Management and administration of SGNP. To deal with financial matters in park.	1
3.	Assistant Conservator of forests	To assist DCF in forest administration and crime control	1
4.	Deputy Engineer	To prepare plans for various constructions works in the division.	1
5.	Veterinary Doctor	To look after captive animals like lions, tigers, crocodile' etc.	1
6.	Range Forest Officer	Wildlife conservation, control tourist activity, maintain and upgrade tourist facilities, development in park etc.	5
7.	Range Surveyor	Forest boundary marking, surveys, and to deal with legal matters related to park boundary etc.	1

Sr. No.	Organization Member	Roles & Responsibilities	Total Number
7.	Forester	Assist RFO in his work related to particular round such as to prevent encroachment, control tourism etc.	12
8.	Forest Guards	Park surveillance in a particular beat. Prevent illicit felling of trees, encroachment etc.	105

Source: Draft Forest Management Plan(2001-10) and data collected from Division office of SGNP.

Beside the members listed above there are many supporting members to this list such as accountant, steno, motor launch driver, cleaners, animal keeper, gardener, watchman, arms police constable etc.

5.4.2 Administrative Infrastructure

Roads

The network of the roads inside the park mainly consists of roads approaching from the three entrances to the park in addition there are few forest roads, which are used for the park management. Currently the total length of the various types of the roads within the park is 63 km. Road network inside the park is not adequate and majority of the areas are approachable by walking through the forest.

Telephone and Wireless system

Currently there are 8 telephones that help in quick communication and exchange of information within field staff. In order to enhance the communication efficiency wireless network was installed within the park. Maharashtra Electronic Corporation, Mumbai (MELTRON) had carried out a survey in 1990 for wireless network installation.

It was noticed at the time of interviews with forest officials and guards that the wireless sets are not in working condition. Wireless sets were not available with any of the field staff.

Vehicles

There are 5 jeeps in the division for executive use by DCF, ACF, RFO circle squad and deputy engineer. There are 5 minibuses for lion and tiger safari, 3 motorcycles, 1 tractor and 2 tempos. Considering the large area and difficult terrain, this infrastructure is not sufficient for various tasks such as surveillance and patrolling, fire fighting etc.

Park Security

The security function mainly consists of patrolling the entire area for trespassers and keeping a watch at the periphery to prevent encroachers from entering the park and establishing permanent residences and for other tasks such as forest fire detection etc. Watch is also kept in the Bassein creek by motor launch to keep a check on illegal felling of trees and transport of the same.

Security in the park area needs a lot of improvement. Infrastructure such as communication (wireless sets), arms and ammunition for forest field staff, fast conveyance, watch towers etc. are totally inadequate and are major roadblocks hampering discharge of the security function by forest staff. All this needs to geared up after conducting detailed studies for requirements and also keeping the High Court orders in mind.

Check Posts

There are two check posts situated along the western Express highway. One is at Dahisar and another is at Versova. Considering the hilly and undulating terrain of the park the existing number of check – posts is not adequate.

There are a total of 4 entry points –

- The main entrance at Borivali
- The Aarey gate or elephant gate
- The Bhandup Complex entrance
- The Yeur gate

However only two i.e. Yeur and Borivali entrances are open to public. Other entrances are used only for management purposes. At the time of special occasion such as on Mahashivratri Day, additional barriers are erected at vulnerable points in order to regulate and restrict the entry to tourists.

Staff Quarters

Residential premises are available for most of the forest staff inside the park. Details of residential quarters, administrative buidings, rest houses etc. are given in **Tables 5.3 and 5.4** below. The quality of staff quarters need to be upgraded.

Table 5.3 – Details of Staff Quarters

Sr.No.	Type of Quarters	Number of Units
1	Non – type	12
2	Type – I	63
3	II	22
4	III	12
5	IV	1
6	Labour	68

Table 5.4 – Details of Buildings, Rest House, Garage etc.

Sr. No.	Type of Building	Number of Buildings
1	Administrative buildings	18
2	Rest house	14
3	Toilets	19
4	Canteen	1
5	Picnic shed	2
6	Animal enclosures or Cages	6
7	Pump house	12

CHAPTER 6 SIGNIFICANT ENVIRONMENTAL ISSUES IN SGNP

6.1 INTRODUCTION

The main aim of this chapter is to list issues in SGNP, which could significantly impact the environment and also to describe related existing management practices for such issues. The issues covered range from encroachment to environmental education and from forest fires to eco-tourism. This chapter serves as a baseline for the preparation of environmental management plan. Each issue is studied, analysed and its current management method is described.

6.2 METHODOLOGY

The methodology included:

- Extensive field surveys in all ranges of the park and park periphery.
- Interviews with forest officials, forest guards and people residing in and on the periphery of the park to gain their perspective.
- Review of relevant literature from local and national sources such as the Draft Forest Management Plan, SGNP.

Photo 24 in **Annex 4A** shows our team with forest officials *Hanuman Hill* at Vihar beat at the time of surveying. Powai lake can be seen in the background.

The following sections describe the environmental issues, which need attention, in each range of SGNP.

6.3 Krishnagiri Upvan

This range is spread over an area of 5.88 sq. km. divided into one round and two beats. The range is mainly known for tourism activity.

6.3.1 Tourism

6.3.1.1 *Observations*

The tourists in SGNP include mainly picnickers, pilgrims and wildlife and nature enthusiasts. Majority of the visitors are in the first category and are mostly interested in recreation. Visitors also include persons attracted by bird watching, nature photography, wildlife viewing, trekking, archeological sites and numerous other special interests. Eco-tourists are a diverse socio-economic mix, ranging from university students to high-income professionals and from morning exercising people to religious.

Main attractions in KUP include:

- Lion and tiger safari
- Mini train (Van Rani)
- Crocodile, deer and leopard park
- Gardens / children parks (7 Nos.)
- Information Centers
- Gandhi Mandir

1. Minitrain was donated to SGNP by "TELCO" a company of the leading business house of TATA. This popular ride of 2.5km length is enjoyable for both young and old. The capacity is 70 – 80 heads per round. It takes a 20-minute round via Gandhi Temple hill through different areas such as leopard, crocodile and Deer Park. The train rides have been discontinued due to paucity of funds for maintenance of the train and the tracks. Refer **photo 25** in **Annex 4A**, which shows mini train in non-operating condition.

2. There are total seven gardens/ children parks in KUP range such as –
   - Rose Garden nos. 1 & 2.
   - Nursery – There are two nurseries, one is for wild species and another is for ornamental species.
   - Children's park – This is near to tiger safari. There is an orientation center near this park that provides information about tiger's life behaviour and some clips on wildlife.
   - Garden present on left side of the main gate entrance
   - Garden near KUP range office
   - Park located on Gandhi hill

3. Information Center – There are total 3 information centers in the SGNP. One of it is located in KUP range.

4. Boating – This facility is available in Dahisar Lake. Currently it is not in operation and plans are to start it in this year.

6.3.1.2 *Issues Needing Improvement and Current Management Practices*

- Amenities available for tourists are very meager. There are no cafeterias and sanitary facilities in the tourism zones. Dedicated parking spaces are not available. Nature trails are not properly maintained. The rest houses are in a dilapidated condition with meager sanitary amenities. Camping sites and locations are very few and not maintained. A lot of attention needs to be paid for improving tourism amenities in the park.

- Currently there is no mechanism for promoting tourism in SGNP. The only media is distribution of SGNP brochure at SGNP gate. This needs to be improved significantly to attract nature lovers and other tourists.

- The train is not in operation since July 1, 2000, due to lack of funds for maintenance of the train and tracks. Train track and station building need to be renovated and beautified to attract visitors.

- In Deer Park around 14 animals were observed, but the condition of the enclosures and surrounding aesthetics was not satisfactory. The surrounds need considerable improvement. The animal cages along the rail track need to be redesigned and enlarged to suit the animals' habitat. (See **Photo 26** in Annex 4A)

- Some of the gardens such as rose gardens are well maintained, however landscaping in other public gardens could be improved. There are no major attractions for children visiting the Park. Children parks need renovation and some extra attractions for children. (See **Photo 27** in Annex 4A).

- The current staff available for managing tourism activities is not sufficient and are not trained to impart awareness in a systematic manner. The information center used for creating awareness in visitors, houses old material, which needs to be updated with more recent and realistic educational tools.

- Domestic solid wastes such as paper, plastic bags were observed to be dumped at road intersections, particularly near forest quarters and Pada's. A

Solid Waste Management Plan in tourism zone is needed for maintaining it clean and beautiful.

A plan entitled "Proposed Eco – tourism and Conservation Plan for SGNP" has been prepared by Conservator of Forests, Borivali. This plan is prepared for enhancing tourism in the entire SGNP and has a financial outlay of about Rs. 20 crores. Several proposed steps envisaged for promoting eco-tourism in SGNP, such as:

- Creating additional tourism zones
- Upgradation of existing roads and sanitary facilities
- Soil and moisture conservation
- Improvement of camp sites, nature trails etc.

More details are given in **Chapter 7** on Environmental Management Plan. Proper planning of the tourism zone and its activities will go a long way in preventing degradation of this zone. This will also help in increasing forest revenue.

6.3.2 Industry

6.3.2.1 *Observations*

Mafco is the only industrial unit situated inside KUP range. Activities here included pig meat processing. The unit has recently been closed due to a High Court directive. Due to lack of proper effluent treatment and solid waste management, the area around the unit is contaminated with animal carcasses and other wastes. Partially treated effluent was let out into ponds, which have become septic. These conditions have caused overall degradation of surrounding area.

6.3.2.2 *Issues Needing Improvement and Current Management Practices*

Photos 28, 29 and 30 in **Annex 4A**, depicts degraded land around Mafco unit. The degraded area needs urgent attention such as remediation or closure of effluent ponds, removal of solid wastes including animal carcasses and plantation in deforested areas.

The Mafco factory and its infrastructure is proposed to be revamped and developed into a tourist education and camping site by Forest Department. The details are presented in **Chapter 7**.

6.3.3 Residential Settlements

6.3.3.1 *Site Observations*

The tribal settlements at Yeur, Nagla and Chenna are traditional but the settlements in and around the Krishnagiri Upwan and Kanheri Caves are relatively recent, and may not have existed prior to 1950 (Econet, Ref. 1, Annex 4B). There are 10 padas situated inside the KUP range namely *Dam, Tala, Malyacha, Chinchpada, Chuna, Nava etc*. These are mainly adivasis and khandeshis. Some of the pada dwellers are working in forest department as labours and field staff. These hutments are considered as encroachment by forest department.

Littering of domestic solid wastes such as plastic bags and garbage was observed near the Pada's and forest quarters. **Photo 31** in Annex 4A depicts this situation. This creates unhygienic conditions and also erodes the aesthetic value of the area.

Residential quarters for forest officials are located in the KUP range. Details are given in Chapter 5. These quarters for forest officers are old dwellings and were found to be generally inadequate as compared to their counterparts for officers found outside in the city.

6.3.3.2 *Issues Needing Improvement*

Domestic solid waste is sent to municipal dumps however a lot of improvement is needed in handling and interim storage of wastes. There is no waste management plan in SGNP for handling solid wastes. Small hutments are proposed to be relocated in some corner of the forest (mostly in KUP range) so that inside disturbance could be minimized. Forest staff quarters will be kept as it is.

In pada dwellings, open defecation is a common practice. Some forest quarters have got septic tank facility. Sanitary facilities in the dwelling need to be improved. Also the forest quarters need improvement to upgrade the living conditions of the forest officers.

6.4 SGNP Range

The range is spread over an area of 38.56 sq. km. and is divided into 4 rounds and 11 beats. This range had the maximum human encroachment problem. Issues related to SGNP range are discussed below. Problem areas are plotted on a map and are presented in **Map No. 6.1 to 6.4.**

6.4.1 Quarry Operations

6.4.1.1 *Site Observations*

There are several operating stone quarries located immediately adjacent to the western boundary of SGNP. Due to continuous heavy quarrying operations, the topography of the area is being permanently altered. Some observations made at these quarries are as follows:

1) *Stone quarry near Mahindra factory (42/A).* Cracks were observed near boundary line inside park area. **Photo 32** in Annex 4A, shows the cracks near the forest boundary due to blasting operations at the quarry. As these quarries are expected to continue operations for several years, these cracks could intensify and could cause collapse of the entire slope.

   High levels of dust emissions were observed due to stone crushing and hauling operations in the quarries. This dust ultimately settles on forest plantations and nearby residential areas. No environmental protection measures such as water sprinkling and other good environmental practices were observed. **Photo 33 and 34** in Annex 4A, shows some of the quarry operations at the boundary.

   These problems were also observed at other quarries adjoining the park boundary such as Raheja quarry near southern tip of Malad beat, three quarries on the forest periphery (345/A). **Figure No. 6.2** shows the quarry locations – (Saibaba, Royal, Mahavir quarries).

2) *Shaikh Quarry* – This was the largest quarry and had extended illegally to a large distance inside forest land. It is located on the boundary of Mumbai suburban district and Thane district near Dahisar area. **Photo 35** in Annex 4A shows the extent of degradation caused in the forestland due to quarry operations. The quarry is currently shut down due to a High Court ruling and existing assets such as crushers etc. have been seized and sealed by forest officials.

Table 6.1 given below gives the operating quarries on the boundary of the park.

Table No. 6.1 – Quarries near the boundary of SGNP

No.	Name of the Village	Survey No.	Name of the quarry / Mine owner
1	Dahisar (Rawalpada beat)	345 / A	K.N.Shaikh
2	—"—		Maharashtra Land Development Corporation
3	—"—		Mahavir
4	—"—		Royal
5	—"—		Saibaba
6	Malad	42/ A	Shri. V. Narayan Raju
7	—"—	—"—	Shri. T. Chaube

6.4.1.2 *Problems created by quarry operation*

- Irreversible damage to topography of the area
- Destruction of vegetation / tree growth leading to deforestation and soil erosion
- Damage to wildlife habitat
- Large scale erosion of the top soil
- Air pollution especially due to dust emissions
- Threat to wildlife on account of blasting (noise and vibration impacts)

6.4.1.3 *Existing Management practices*

- As discussed before, environmental management in the quarry operations was found to be non-existent. The District Collector of Mumbai licenses these quarries. Specific environmental safe guards are required to be implemented by quarry operators as per the license. The entire implementation is regulated by the Collector's office, Indian Bureau of Mines and Director General of Mine Safety (DGMS). The park management is not directly involved with these operations.

- Forest Department has put some efforts for rehabilitation of the degraded area of Shaikh quarry by using craters as new water holes. See **photo 35** in Annex 4A, which shows waterholes created in old quarry area. After closing down the quarry and making these extra water holes; wildlife and bird sightings have improved in the area.

- Environmental safe guards for minimising dust emissions, rehabilitation of quarried land for preventing soil erosion etc. needs to be practiced very seriously by quarry operators. These measures are to be implemented by the District Collector. This is discussed in more detail in **Chapter 7.**

6.4.2 Encroachment of Park Area

The Park is situated in the metropolis of Mumbai and Thane. Due to pressures of urbanisation, population explosion and political interference, squatter and slum settlements have sprung up near park boundaries and have encroached into forest land. The problem of encroachment for settlement has been recorded in the areas of acquired forests. Encroachment started from 1970 onward and the phases of encroachment are 1970 –85, 1985 –94, after 94 to till date. The third phase was the most disastrous.

6.4.2.1 Observations

The encroachments in forest area on Malad and Kandivali side included Gandhinagar / Bhimnagar (87/A), Gautam Nagar, Damunagar, Pimpripada, Devi pada etc. Ghatipada, Shankar tekadi etc. are some of the encroachments on Mulund side of the forest. Ketkipada is one of the major encroachment settlements located near Dahisar area. Refer **Map No. 6.1, 6.2 and 6.4**.

The Tata Powerhouse Zopad Patti is situated to the south entrance of SGNP, which is one of the largest slum encroachments around SGNP range. These encroachments extend towards another area known as Devi pada and Chinch pada. Both these padas are inside the park boundary. As per the Draft Forest Management Plan (2001-10) most of the bootleggers and producers of illicit liquor are believed to be in Devi pada. The Warlis and other adivasis are running practically all of these. **Table 6.2** given below shows encroachment details from 1991 to 2000.

Table 6.2 Encroachment Cases in SGNP

Year	Number of Cases	Number of Offenders
1991-92	132	219
1992-93	101	71
1993-94	135	56
1994-95	206	75
1995-96	292	92
1996-97	254	66
1997-98	74	43

1998-99	82	53
1999-2000	51	32

Source: SGNP Division Office, Borivali

6.4.2.2 *Environmental Problems due to Encroachment*

Nearly one million people are staying on the outskirts of the park and there is a growing tendency among these people to encroach on the open land to construct unauthorized hutments. It has been alleged that all political parties encouraged slum dwellers to encroach into forestland and openly declared that such encroachments would be regularized. Falling prey to the political overtures, almost the entire bureaucracy in Mumbai and Thane districts played a key role by promising regular water connections, telephone connections, public toilets, ration shops, primary schools and all other civic amenities in the illegally encroached area. (*Source: ECONET Report, 1997*).

Encroachment problem is severe in this range and has caused the highest damage to forest ecology. Problems caused due to this activity are:

- Extensive Deforestation and Soil erosion
- Disturbance in wildlife habitat
- Illegal use of forest resources
- Increase in forest fire incidence
- Trespassing
- Proliferation of weeds
- Solid waste disposal (mainly in padas which are still to be demolished)

Photo 36 in Annex 4A, show the heavy encroached areas before demolition in Malad round. Also notice the extensive deforestation and general degradation of this area. Similar pattern was observed in all other encroached areas.

6.4.2.3 Current Park Management

Encroachment Evacuation:

Following the High Court order dated May 7th, 1997, the forest department has made commendable efforts for removing the encroachments on forest land. Majority of the encroachments have now been removed. Most of the hutments on Kandivali, Malad and Bhandup side have been demolished in the year 2000. The remaining people will be rehabilitated to other areas. Illegal "Ashrams" or places of worship, established by self proclaimed "God Men" in the Kanheri Caves area have been demolished in November 2000.

Difficulties encountered in evicting these encroachments have been reported by forest department to be -

- Lack of proper fencing along the periphery of this division
- Insufficient police protection
- Insufficient field staff

There were a total of 63,000 huts in the encroached areas in 1997. After the High Court's order on March 7, 1997 demolition work had simultaneously started. The demolition statistics, is given below –

Year	Number of huts removed
October1997 – 98	12,000 huts
1998 – 1999	15,000
1999 – 2000	22,000
Total huts removed:	49,000

Source: SGNP Division Office, Borivali

Remaining 14,000 huts, which are spread over an area of about 50 acres, will be removed after High Court's order. The area includes Ketkipada and Mulund encroachment.

Construction of Boundary Wall:

Another serious problem is preventing the reentry of encroachers on evacuated land. For this purpose the Court order also included construction of boundary wall with watchtowers every 500 meters.

Following are the construction details during 1998 – 2000.

Table 6.3 Statement of Construction of Boundary Wall

Round	Proposed Length of boundary wall (mtr.)	Construction of wall completed (mtr.)	Yet to be constructed (mtr.)
Malad	8,755	580	8175
Gundgaon	3762	1278	2484
Yeur	9483	956	8527
	22,000	2814	19,186

Source: Draft Management Plan for SGNP (2000 –10)

Rehabilitation of Evacuated Land:

After demolishing the illegal hutments in park boundary, forest department has implemented afforestation programs. Several benefits have been observed after plantation activities such as increased spotting of deer, birds and leopard's.

Details of the area and species of plantations are given below in **Table 6.4. Photo 37 and 38** in Annex 4A **depicts** plantation in Mulund and Aakurlee side respectively. Approximately 100 hectares of area is yet to come under plantation.

Table 6.4 Recent Plantation Status In SGNP Range

Year	Round / Beat	Area	Number of Plants	Species planted
1998-99	Malad round S.No. 239/1	10 hectares	16,000	Vaad, Jambhul, Karanj, Sawar, Gulmohar, Bamboo, Shisav, Shivan, Kashid, Chillar, Mango
1996-97	Gundgaon Round Malad (Poisar)	4 hectares 7 hectares	10,000 17,500	
1999	Malad Aakurli S.No. 87/A (Refer **Photo 39**)	41 hectares	26,625	Karanj, Bamboo, kalamb, Ritha, Khair, Bahawa, Shivan, Chinch, Kawat, Chillar, Shisav, Jambhul, Subabhul, Palas, Neem, Kaju, Gliricidia, Mango
1997 –99	S. No. 377/ 351 Mulund boundary of SGNP	-	-	Subabhul, Acasia.

Source: SGNP Division Office, Borivali

A patch of land near Mulund boundary (Survey No. 377/351) came under the control of Forest Department in 1969. This area of over 20 ha was afforested in the years 95 to 97 and was called 'Nisarg Vihar'. This green area was initially open to visitors, however it has been closed due to increased human activity and interference. A patch of survey Nos.374 /351 nearer to Pachpakhadi Boundary of the Park has Teak Plantation. Plantation is normally maintained by the forests guards and labourer's. Refer **Map No.6.1 and 6.4**.

6.4.3 Forest fires

6.4.3.1 *Observations*

In SGNP, 71 cases of forest fires were reported in the year 1998-99, which damaged about 340.02 Ha of forest standing crop. Fires have been recorded at many places such as, Malad round, Mulund boundary of the park, Kanheri beat, Ravalpada side. **Photo 39** in Annex 4A shows small forest fire patch in Malad forest.

Causes - The vegetative growth under moist tropical conditions is not normally subjected to severe fire hazard, but after February some grasses become flammable and if ignited can damage the forest undergrowth. Most of the time the forest fire is man made. It has been reported that trespassers and encroachers often start fires deliberately or unknowingly. **Table 6.5 and 6.6** below give the yearly trends of forest fires and area wise fire statistics respectively. It can be seen that incidences of forest fires have steadily increased over the years after 1992. Also, highest incidences of forest fires have been reported in Kanheri and Malad areas, which are prone to visitors and encroachments respectively.

Table 6.5 Forest Fire Statistics from 1991 to 2000

Year	Number of Cases	Area burnt (Hectares)
1991-92	36	63.50
1992-93	25	124.80
1993-94	40	249.00
1994-95	56	143.30
1995-96	61	109.00
1996-97	81	248.00
1997-98	33	129.00
1998-99	71	340.22
1999-2000	60	165.20

Source: SGNP Division Office.

Table No. 6.6 Forest Fire Statistics for the Year 1999-2000

Sr. No.	Name of Place	Area under forest fire Hectare
1.	Kanheri	64.0
2.	Malad	36.5
3.	Gundgaon	21.0
4.	Tulsi	15.0
5.	Nagla	04.0
6.	Chenna	02.0
7.	Yeur	06.0
8.	Ghodbandar	1.50

Total Area under forest fires 415 acres.

Source: SGNP Division Office, Borivali

6.4.3.2 *Current Measures to prevent and fight forest fire*

- Fire tracing on either side of roads to about 5 meters – fire tracing has been done along 64 km road length area along the main and internal roads on both sides
- Fire Lines - Fire lines are drawn in the month of December. The regular fire zones are separated by 30 ft. Nallah or ridges act as natural fire lines
- Beating method – beating the fire with green tree branches

Table No. 6.7 Details of fire tracing works

Sr. No.	Range	Along the main on Both sides {km.}	Along the internal Road on both sides (km)	Total (km)
1	Sanjay Gandhi National park	19.00	45.00	64.00
2	Yeur	---	68.00	68.00
3	Krishnagiri Upvan	3.00	6.00	9.00
	Total	22.00	119.00	141.00

Source: Draft Forest Management Plan for SGNP, Borivali (2000-10)

6.4.3.3 *Issues Needing Improvement*

- Comprehensive Forest Fire Control and Prevention Plan should be developed and implemented.
- Fire detection and communication infrastructure needs to be improved significantly by way of additional watch towers, extra manpower, improved communication network

- Fire fighting infrastructure to be improved. Additional fire fighting equipment needed.

Details of issues to be considered in a Forest Fire Management Plan are presented in **Chapter 7.**

6.4.4 Soil Erosion

6.4.4.1 *Observations*

Soil erosion has mainly been observed in areas, which have been encroached, area degraded due to quarrying activities and areas where deforestation and trespassing is common.

6.4.4.2 Issues Needing Improvement and Current Park Management

There are 10 check dams constructed in this range within 10 years and 250 nalla bundings have been completed. It is proposed to build 30 check dams or anticuts in the park during 5 years. In coming years the target is 300 - nalla bunding. No bunds have been created in Mulund area. Also plantation to prevent soil erosion has been carried out by forest department in degraded areas as mentioned before. These are mentioned in more detail in **Chapter 7**.

The whole park division has been divided into 5 moisture cum soil conservation series (MCSCS). Each series has been divided into micro watersheds. One micro watershed will be treated during the plan period. In each MCSCS, the works of soil and moisture conservation will be started from the top and gradually the works will be moved down to the bottom. The works in MCSCS will be mainly gully plugging, check dams/nallah bunding, depending upon the status of soil erosion.

6.4.5 Weed / Termite Issues

Site observation

Weed and termite infestation is not a major problem in SGNP. Minor termite infestation was observed in Poisar, Mulund side and Aakurlee. Refer **Photo 40** in Annex 4A, which shows termite contamination on teak bark.

Issues needing Improvement and Existing Park Management

Currently no specific weed and termite control measures are available in SGNP.

1. Further spread should be checked and effective weed control measures such as uprooting should be followed. Each block should be uprooted for 3 consecutive years.
2. Areas infected by weeds should be cleared periodically and planted with suitable local fruit / fodder species useful to the existing wildlife.

6.4.6 Residential Settlements

There is only one adivasi pada situated in SGNP range and few small settlements where forest labours stay. Some of the pada dwellers are working in forest department as labours and field staff.

Issues needing Improvement and current park management –
This is previously discussed in detail in **Section 6.3.3.**

6.4.7 Industries

Some large industries are located close to the park boundary, mainly at Malad, Goregaon, Dahisar and Thane City. Most industries are medium scale chemical and engineering in nature. Air emissions from these industries are the only pollutants that could have an impact on forest land. However, the nature and quantity of emissions does not appear to have a significantly negative impact on the forest ecology.

6.4.8 Tourism Activity

Site observations
The major tourist attraction in this range is Kanheri caves. This is a famous tourism and archaeological study site, which is more than 1000 years old. Archeological Department of India is responsible administratively for Kanheri caves. Forest areas surrounding these caves form parts of the core zone of SGNP.

Environmental Issues Needing Improvement
On *Mahashivratri day* about two lakh people visit the caves. Previously illegal Ashrams situated in vicinity of the caves were additional crowd attracting center for these tourists. In November 2000 forest department had demolished all the three ashrams. This year the tourist inflow was found to be less compared to previous years. Mahavir Jayanti is another day on which tourist inflow is recorded as high.

On both these days, human stress on forest ecology is evident. The following problems are observed:

- Careless littering of solid waste
- Increased incidence of Forest fires
- Disturbance to wildlife habitat
- Higher levels of dust pollution
- Higher levels of noise pollution

Existing Park Management

Efforts should be towards sustainable tourism. Every year Bombay Natural History Society (BNHS) assist forest department people in managing and guiding the crowd on Mahashivratri day so that problems due to this can be minimized.

New Forest Management Plan gives emphasis on displaying information at suitable places in the vicinity of Kanheri Caves. These exhibits will provide information on forests and their protection. The signs should also give messages for proper disposal of wastes, do's and don'ts for preventing forest fires etc.

6.4.9 Lakes and their Catchments

6.4.9.1 Site Observations

- Backwash water from Tulsi filtration unit is drained into Vihar lake (near northern edge of the lake). However, Vihar water quality does not indicate any significant pollution due to this activity.
- Overall Tulsi lake catchment is well protected. The catchment area of Vihar Lake was found to be covered with degraded and in few areas moist deciduous forest patches. Rest of the catchment had tree plantation done of exotic species like *Australian acacia* and *Gliricidia sps*. Human interference at many locations was noticed during the sampling periods. Although the catchment is protected, intrusions by surrounding settlements such as Phule Nagar in the east (**Photo 41** in Annex 4A) are rampant. Instances were observed of people from surrounding squatter settlements using the lake water for washing, bathing and other domestic uses (**Photo 42** in Annex 4A).

6.4.9.2 Environmental Issues needing improvement

- As discussed above, human trespassing in Vihar lake needs to be kept in check.
- Soil erosion at certain patches need to be controlled to prevent siltation.

6.4.9.3 Current Management

The catchment areas of Tulsi and Vihar Lakes are under the control of MCGM (Municipal Corporation of Greater Mumbai). As per discussions with MCGB, there is no existing catchment area protection plan. Some plantation has been done by MCGM in the catchment area, however, this activity needs to be done systematically after a detailed survey of the catchment to identify specific soil erosion and degraded patches.

Issues to be considered while preparing catchment areas plans are discussed in **Chapter 7.**

6.5 YEUR RANGE

This range is spread over an area of 58 sq. km. This range is divided in total 4 rounds and further into 12 beats. Environmental issues needing attention in SGNP range are discussed below. Problem areas are plotted on maps and are presented in **Map No. 6.5 to 6.7.**

6.5.1 Encroachment

6.5.1.1 Site Observations

1. Warli pada – S. No. 374/ 351. Both the encroachments are partly in forestland and disturb wildlife. Also, the people use forest resources for many of their needs. Problems due to the encroachments are similar to the ones explained in **Section 6.4.2.**
2. An ashram was observed at Shrinagar Hill, Thane.

Issues needing Improvement and current park management

Settlements that are located on the forest boundary use forest resources and disturb wildlife habitat. Other problems and management practices are similar to SGNP range discussed in **Section 6.4.2** in this chapter.

6.5.2 Villages and Other Properties inside the Park area

6.5.2.1 Observations

Yeur and Chenna Village are two settlements, which are not the part of SGNP but are situated in the Park area.

Yeur Village – This is located at eastern part of the park area. Yeur is a revenue village of Thane district and administration comes under Thane Municipal Corporation (TMC). Population of the village is about 3500. Yeur is Warli dominated village with poor literacy rate. School facility is available till standard seven. Dispensary and private physicians are also available. Thane Municipal Transport (TMT) has regular bus service to Yeur. Majority of the villagers are working in Thane city and surrounding area. Some villagers work as forest labours.

Several farm house type bungalows have been constructed by individuals in Yeur. There are about 125 bungalows in Yeur Village. Some properties are being developed as holiday resorts e.g. The Golden Swan Country Club. Picture of Yeur Village is given in **Photo 43** in Annex 4A. Refer **Map No. 6.6.**

Chenna Village – This is divided as Chenna east and west. Both are revenue villages located inside forest boundary but under administration of Vasai Municipal Council. Chenna Village is also surrounded by SGNP.

Air Force Station – This is a satellite station of Ministry of Defense, located adjacent to Yeur Village, which is used for surveillance against air attacks on the city of Mumbai.

6.5.2.2 Environmental Issues and Current Management

Some problems observed due to these residential settlements are:

- *Trespassing into forest areas and deforestation* – Minor incidences of illegal tree cutting has been observed particularly around human settlements. Surveillance by forest guards is not adequate due to insufficient man-power, lack of communication equipment and personal protection equipment such as fire arms.
- Various locations in the area were littered with municipal waste. Partial collection of solid wastes is done by TMC.
- Incidences of forest fires.

6.5.3 Agricultural land

6.5.3.1 Observations

Vanicha Pada, Chenna and Yeur villages, Nagla block are the main places where agriculture is a common practice on forestland by Adivasis. Nagla block forms the northern most part of the SGNP, Vasai creek separates Nagla block from rest of SGNP. **Photo 23** in Annex 4A, shows agricultural fields in forestland from in Nagla block. Impact due to agriculture is negligible.

6.5.4 Quarries

Manpada and Owale are the places where quarries were seen. **Refer Figure 6.5.** These quarries are not operating presently. They have been shut down by the Forest Department. The problems are same as discussed in **Section 6.4.1**.

6.5.5 Illicit Tree Felling

6.5.5.1 Site observation

This problem commonly occurs mainly in Nagla block. The illicit tree felling is done in an organized manner. On certain occasion timber thieves seriously attacked the forest field staff when the staff attempted to prevent illicit felling. *(Draft Forest Management Plan, 2000-2010).*

Trees of all species have been systematically and regularly felled. Regular patrolling and surveillance by forest guards is hampered by lack of manpower, no communication equipment and no deterrents such as fire arms.

Table given below shows the loss due to illicit felling in SGNP area since 1990.

Table 6.8 Loss Due to Illicit Felling of Trees

Year	Number of Offences	Number of Stumps	Value of Trees (Rupees)	Amount of seized material (Rupees)	Percentages
1990-91	517	1228	6,96,192/-	7,31,599/-	150.08
1991-92	494	1550	6,19,676/-	4,49,309/-	72.50
1992-93	345	1291	4,35,691/-	3,79,860/-	87.19
1993-94	520	2498	11,67,485/-	6,66,,128/-	57.06
1994-95	368	627	5,43,191/-	5,19,769/-	95.69
1995-96	291	440	3,68,488/-	4,67,278/-	126.81
1996-97	224	301	4,05,433/-	7,39,027/-	184.10
1997-98	205	689	9,67,139/-	8,99,113/-	92.96
1998-99	136	295	3,32,417/-	5,69,250/-	171.21
1999-2000	98	126	1,28,980/-	3,64,028/-	282.23

Source: SGNP Division Office.

6.5.5.2 Existing Park Management

The main reasons which prevent field staff from handling the problem effectively are:

- Lack of infrastructure such as fire arms
- Lack of communication systems
- Insufficient staff

6.5.6 Grazing

Site Observations

This problem is mainly noticed on the outer fringes of the park. During site visits it was recorded at Sasunavghar and Chenna forest periphery where human settlements were observed. The adivasis staying within the park do not rear cattle, sheep or goats. Also there are no cattle camps inside the park. The cattle population from the adjoining areas does not penetrate deeply into the park but they make use of the outer fringes. No grazing is regulated inside this division. Grazing is prohibited in the notified areas of the park. Grazing is mainly a problem in the Yeur range. Main problem due to grazing is conflict between domestic and wild animals.

Table presented below summarizes total loss caused by grazing activity since 1991.

Table No. 6.9 Loss of the forest due to Grazing

Year	Number of Cases	Number of Cattles
1991-92	32	133
1992-93	41	229
1993-94	17	149
1994-95	46	167
1995-96	53	210
1996-97	27	139
1997-98	9	27
1998-99	13	56
1999-2000	9	13

Source: SGNP Division Office, Borivali.

Table No 6.8 and 6.9 show decrease in number of tree stumps and decrease in number of grazing cases respectively after 1995-96. Main reasons for this decline are demolition of illegal encroachment, preventing reentry of encroachers by constructing boundary walls on sensitive sides and more surveillance by forest department.

6.5.7 Forest Fires

Site Observations

The details of forest fire incidences in year 1999 –2000 and the total area burnt is depicted in **Table No. 6.4 and 6.5** in this Chapter. Nagla, Chenna and Yeur villages and Ghodbander are the places in this range where forest fire incidences are noticed frequently. This is mainly due to proximity to human settlements.

Issue needing Improvement and current park management

Causes of forest fire and the problems caused are similar to the ones described in **Section 6.4.3**.

Lack of forest fire control equipment, lack of communication facilities and insufficient field staff are some of the major reasons for ineffective control of forest fires. Fire tracing has been done in 68km area along the main and internal roads on both sides in this range.

6.5.8 Man and animal Conflict

Man animal conflict in the area is high. This conflict specifically refers to panthers of this area. Panthers stray outside the forest area and cause panic in the adjoining area. The main factors, which are responsible for this conflict are:–

- Space and prey are insufficient for the panthers
- There is a local abundance of panthers in this area.
- Stray dogs in the region.
- The immediate surrounding of this area has crowded human inhabitation.
- Broken compound walls

Animal hits due to speeding vehicles have also been observed on roads adjacent to the park in this range. According to a study by BNHS (Hornbill, July- Sept, 2000, p. 25) residents of Eden Woods and the neighboring housing complexes in Thane had regularly sighted panthers in the wee hours of the morning.

At least five times in the past two years, a panther was trapped by the Forest Department in the surrounding Ghodbander – Manpada - Kolshet region. All six panthers trapped in the last two years were 3-4 years old and no human was attacked. But residents are concerned about having panthers in their backyard. Range Forest Officer of Yeur has pointed out some causes of this problem –

- Stray dogs in the region serve as prey
- Un-cleared shrubs in the backyard provide a hideout for panthers
- Broken compound walls

- Improper lighting in the concerned locality
- Security personnel of the society are not trained appropriately, keeping in mind the proximity of the society to the national park.

6.5.9 Wildlife Management

In the past the value of wildlife conservation was not recognized and wild animals were subject to indiscriminate hunting. As a result some species became extinct and one of them was the tiger. The last authentic record of the tiger in the SGNP was shooting of the tiger at Vihar lakeshore on January 22, 1929. The tiger has become extinct in this area since early forties.

Wildlife conservation largely depended upon the availability of funds and the subjective judgement of the problem of areas. Holistic approach has been lacking in this management and the result is illicit tree felling problem in totally neglected forest areas such as Nagla block. Krishnagiri Upvan (Tourism zone) received main attention compared to other parts of SGNP.

Problems in KUP zone –

- Tourist inflow beyond the carrying capacity
- Increasing of lions in lion safari would cause a serious problem for management.
- Fighting between the tigers brought from different places in tiger safari.

Threats to wildlife

- Destruction of natural habitats due to encroachment and illicit felling
- Disturbance due to quarrying
- Man animal conflict
- Insufficiency of space and prey leading to the dispersal of young panthers outside the area and finally they being killed by speeding vehicle or other way
- Disturbance due to human settlements inside the park

6.5.10 Security

There are total 4 entry gates and two check posts. Details are given in Chapter 5. Considering the hilly and undulating terrain of the park the existing number of check – these posts are not adequate. The number of forest guards and other staff are not adequate to patrol the entire forest area effectively. Moreover the staff does not have basic equipment such as fire arms, wireless radios, adequate conveyance etc. to be really able to do justice to park security and pose an effective deterrent to trespassers.

KEY FINDINGS

KUP RANGE

- Amenities available for tourists are very meager. There are no cafeterias and sanitary facilities in the tourism zones. Dedicated parking spaces are not available. Nature trails are not properly maintained and the information center houses old education material. The rest houses are in a dilapidated condition with no amenities. Camping sites and locations are very few and not maintained. A lot of attention needs to be paid for improving tourism amenities in the park.

- Currently there is no mechanism for promoting tourism in SGNP. The only media is distribution of brochures at SGNP gate. This needs to be improved significantly to attract nature lovers and other tourists.

- **Children parks** and other attractions such as **animal enclosures** and their habitats need considerable improvement. The animal cages along the rail track need to be redesigned and enlarged to suit the animals habit.

- Domestic **solid wastes** such as paper, plastic bags were observed to be dumped at road intersections, particularly near forest quarters and the Pada's. Small hutments are proposed to be relocated in some corner of the forest (mostly in KUP range) so that inside disturbance could be minimized.

- A Solid Waste Management Plan in tourism zone is needed for maintaining it clean and beautiful.

- A plan entitled **"Proposed Eco – tourism and Conservation Plan for SGNP"** has been prepared by Conservator of Forests, Borivali. This plan with a financial outlay of about Rs. 20crores, consists of several proposed steps envisaged for promoting eco-tourism in SGNP, such as creation of additional tourism zones, upgradation of existing roads, interpretation centers and improvement of camp sites, nature trails etc.

- Mafco unit has recently been closed due to high court order. Due to lack of proper effluent treatment and solid waste management, the area around the unit is contaminated with animal carcasses and other wastes. These conditions have caused overall degradation of surrounding area. The Mafco factory and its infrastructure is proposed to be revamped and developed into a Tourist Education and Camping site by Forest Department.

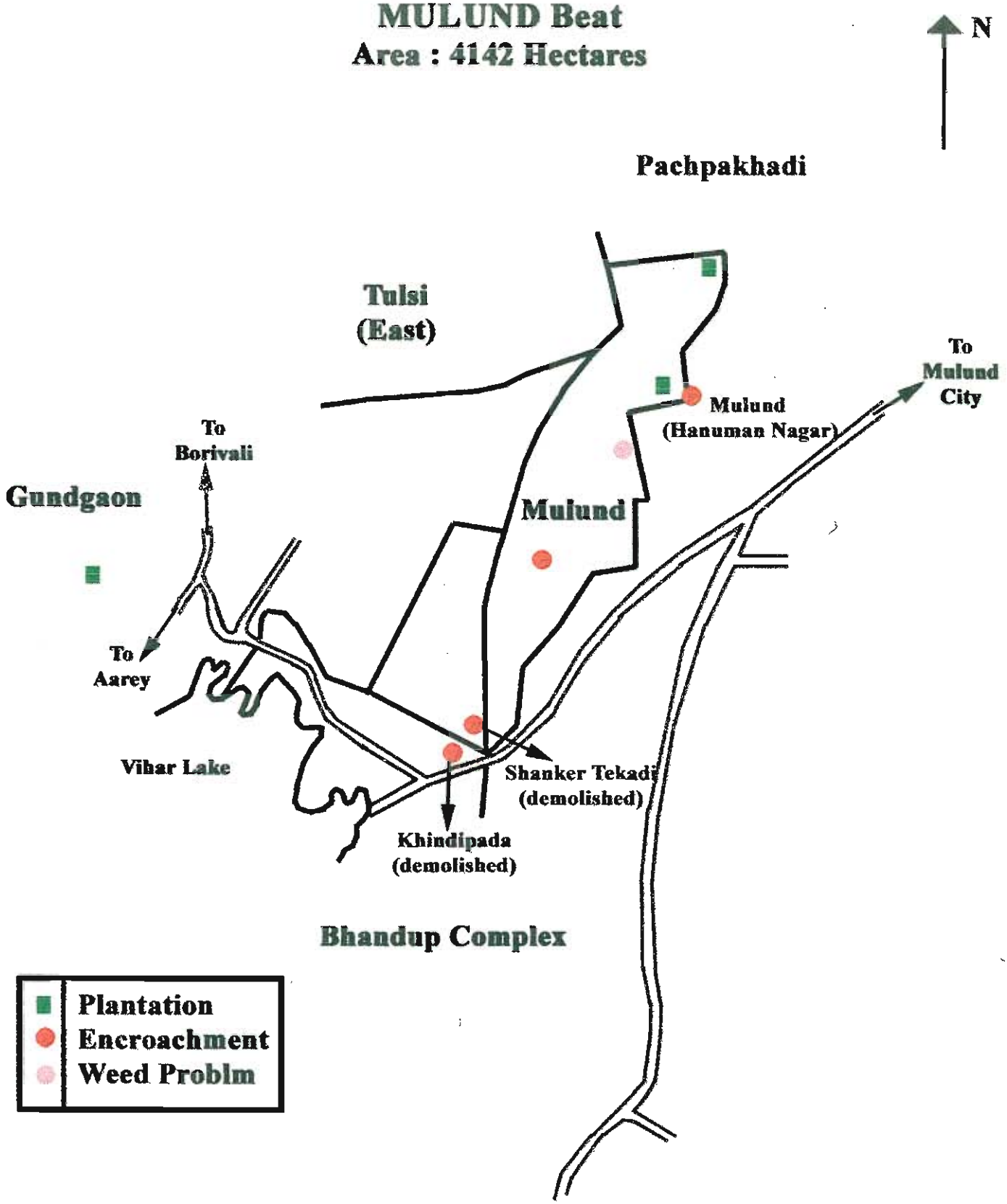
SGNP RANGE

- **Stone quarry's** are located immediately outside the SGNP boundary near Malad side. These quarry's are not following environmental mitigation measures, as a result of which several environmental impacts are observed such as high dust emissions, disturbance to wildlife, high noise levels. An Environmental Management Plan is required for quarries working on the park boundaries.
- Quarry rehabilitation plan is needed for remediating degraded areas of the abandoned Shaikh quarry, which is situated inside the park.
- **Encroachment problem** is severe in this range and has caused the highest damage to forest ecology. Most of the encroachments have been demolished, and a total 49,000 huts have been removed. Demolition of the remaining encroachments, spread over an area of about 50 acres, are awaiting High Court orders.
- In SGNP, 71 cases of **forest fires** were reported in the year 1998-99 that has damaged about 340.02 Ha of forest standing crop. Incidences of forest fires have steadily increased over the years after 1992.
- Facilities for **forest fire detection and control** need much to be desired. Facilities such as wireless radios for communication, fire fighting equipment, personal protection equipment, staff training etc. are needed urgently for effective fire fighting. Also, a comprehensive **Forest Fire Prevention and Control Plan** should be developed and implemented.
- **Weed and termite infestation** has been observed in some patches, although it is not a major problem in SGNP. Currently no specific weed and termite control measures are available, however a Weed and termite control plan should be implemented.
- On some days such as Mahashivratri and Mahavir Jayanti tourist inflow is always high compared to weekends. Main problems caused because of these activities are careless littering of solid waste, incidence of Forest fires, disturbance to wildlife habitat, higher levels of dust pollution. Efforts should be towards sustainable tourism.
- **Lakes and their Catchments** - The catchment area of **Vihar** Lake was found to be degraded in specific areas. Although the catchment is protected, intrusions by surrounding settlements such as Phule Nagar are rampant.
  Natural siltation is another problem seen in Vihar catchment. Plantation has been done by MCGM in the catchment area, however, this activity needs to be done systematically after a detailed survey of the catchment to identify specific soil erosion and degraded patches.

YEUR RANGE

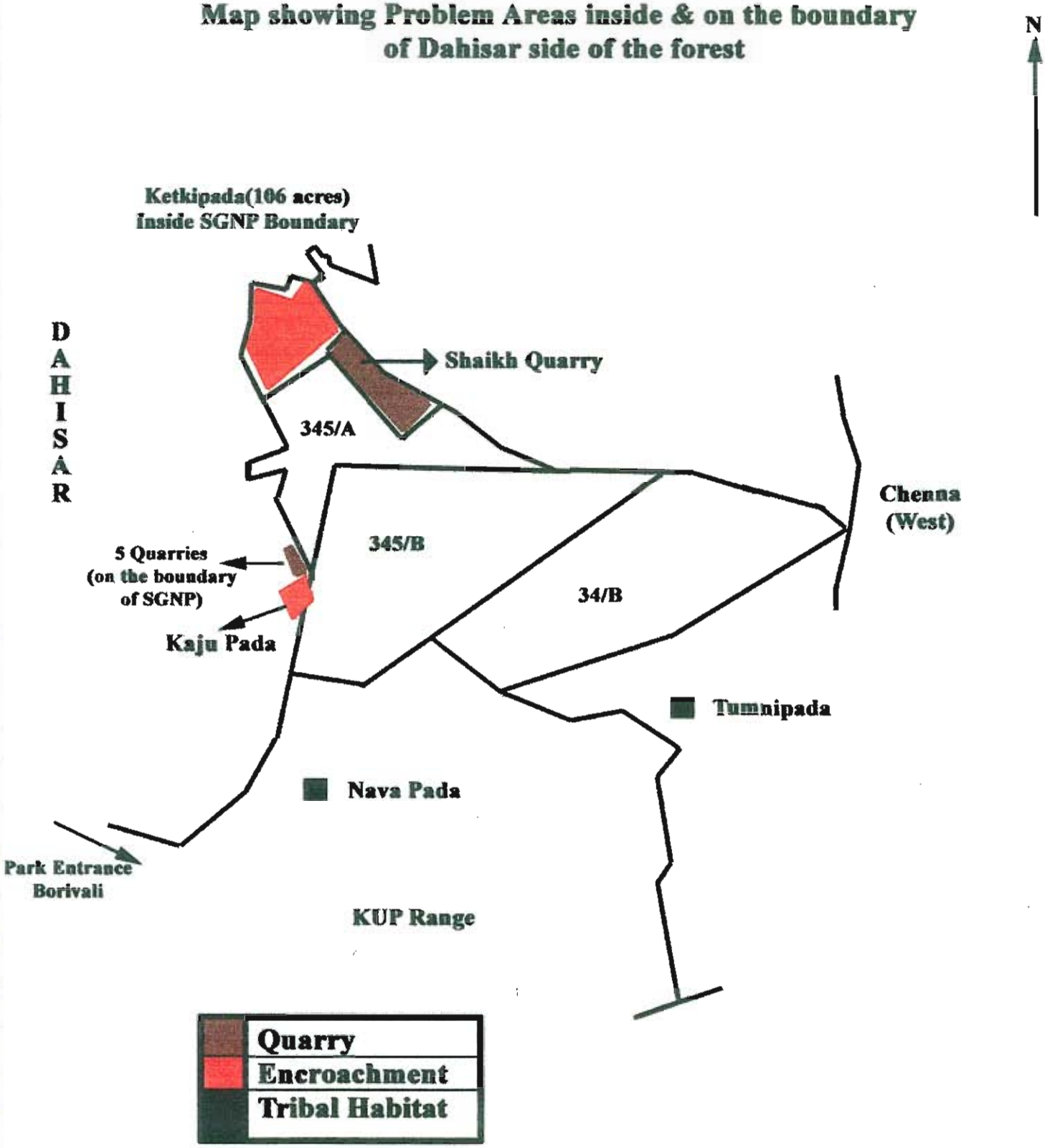
- **Settlements**, which are located on the forest boundary use forest resources, disturb wildlife habitat etc.
- Yeur and Chenna are two villages located inside the boundary of the Park but not under control of forest department. Littering of **municipal wastes**, forest fires, trespassing into forest areas and deforestation are the main problems due to these **revenue villages**.
- **Forest fires** are frequently noticed in surrounding areas of human settlements in the park. Lack of forest fire control equipment, lack of communication facilities and insufficient field staffs are some of the major reasons of ineffective control of forest fires. Fire tracing has done in 68km area along the main and internal roads on both sides in this range.
- Vanicha Pada, Chenna and Yeur villages, Nagla block are the main places where **agriculture** is a common practice on forestland by Adivasis.
- **Quarries** are located on the forest boundary and presently not in operation. The Forest Department has shut them down.
- **Illicit tree felling** is done in an organized manner in Nagla block. Regular patrolling and surveillance by Forest Guards is hampered by lack of manpower, no communication equipment and no deterrents such as fire arms.
- **Grazing** is mainly noticed on the outer fringes of the park. No grazing is regulated inside this division. Grazing is prohibited in the notified area of the park. Main problem due to grazing is conflict between domestic and wild animals.
- **Man animal conflict** in the area is high. Panthers stray outside the forest area and cause panic in the adjoining residential areas. Animal hits due to speeding vehicles on roads adjoining the park is also observed.
- **Security** - Considering the hilly and undulating terrain of the park the existing number of check – these posts are not adequate. The number of forest guards and other staff are not adequate to patrol the entire forest area effectively. Moreover the staff does not have basic equipment such as fire arms, wireless radios, adequate conveyance etc. to be really able to do justice to park security and pose an effective deterrent to trespassers.

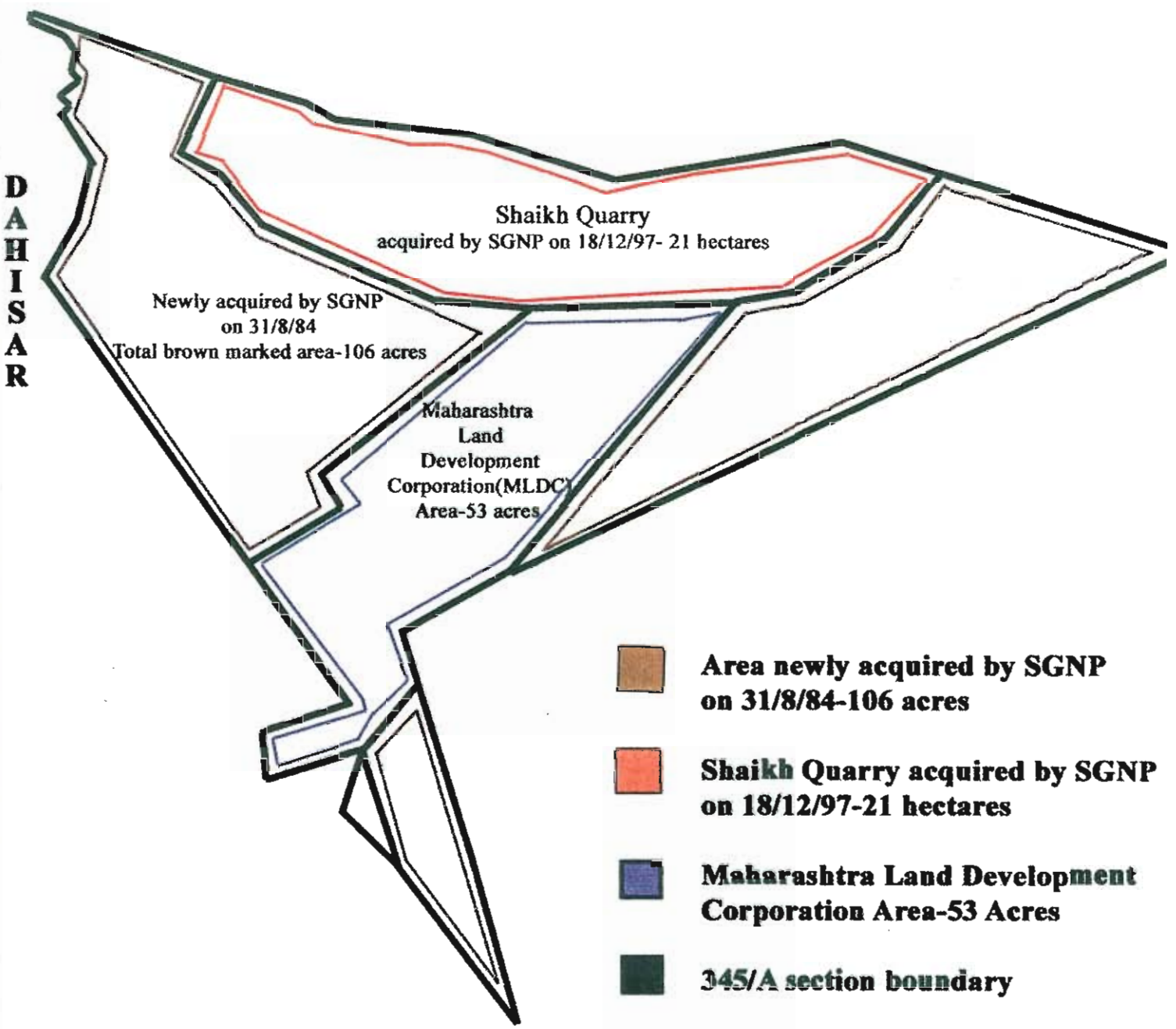
Map 6.1-Tulsi Round
MULUND Beat
Area : 4142 Hectares



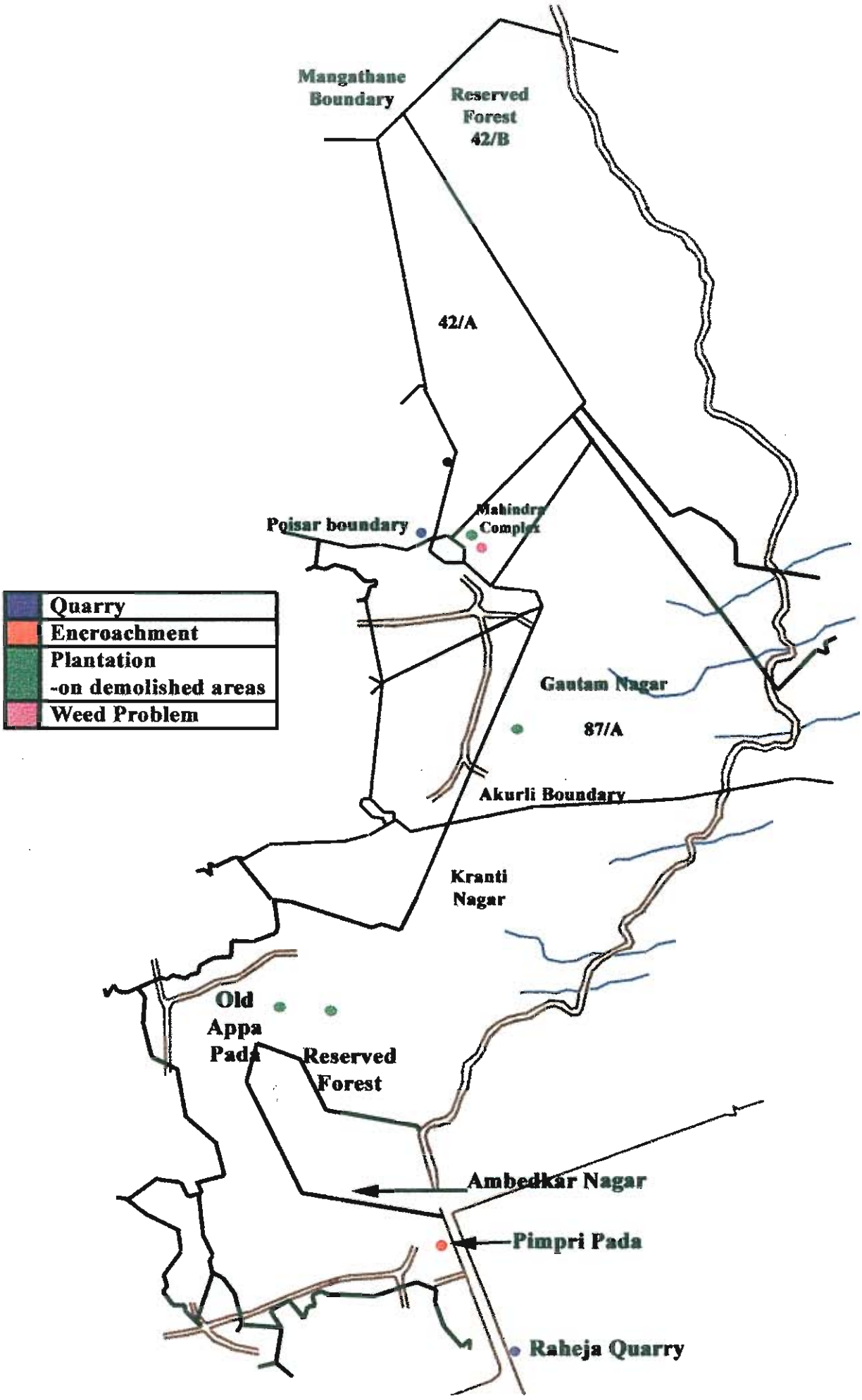
Map 6.2-Kanheri Round
RAWAL PADA Beat
Area : 445.3586 Hectares

Map showing Problem Areas inside & on the boundary of Dahisar side of the forest



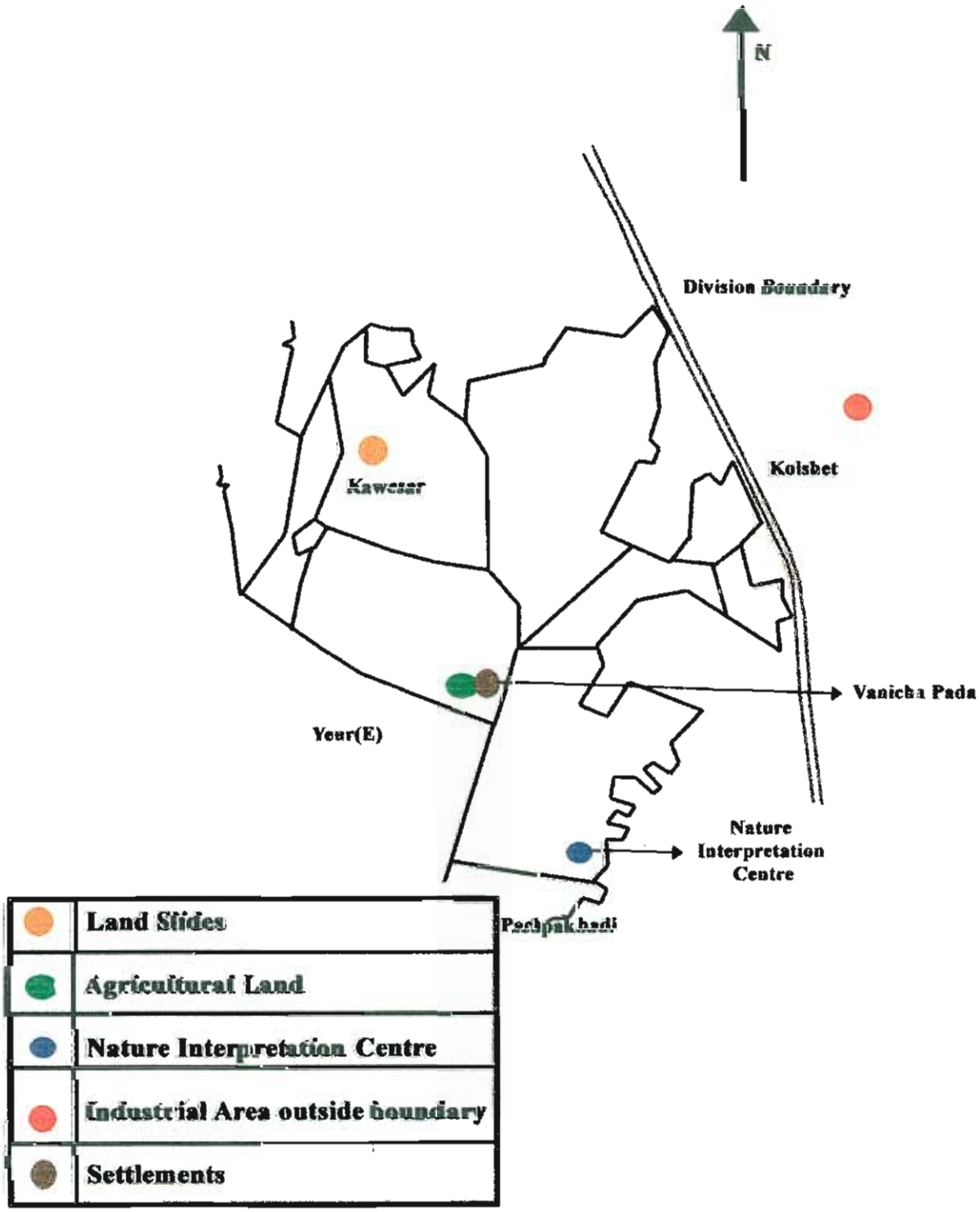


Map 6.3--Map showing 345/A section of Rawalpada Beat (Dahisar)

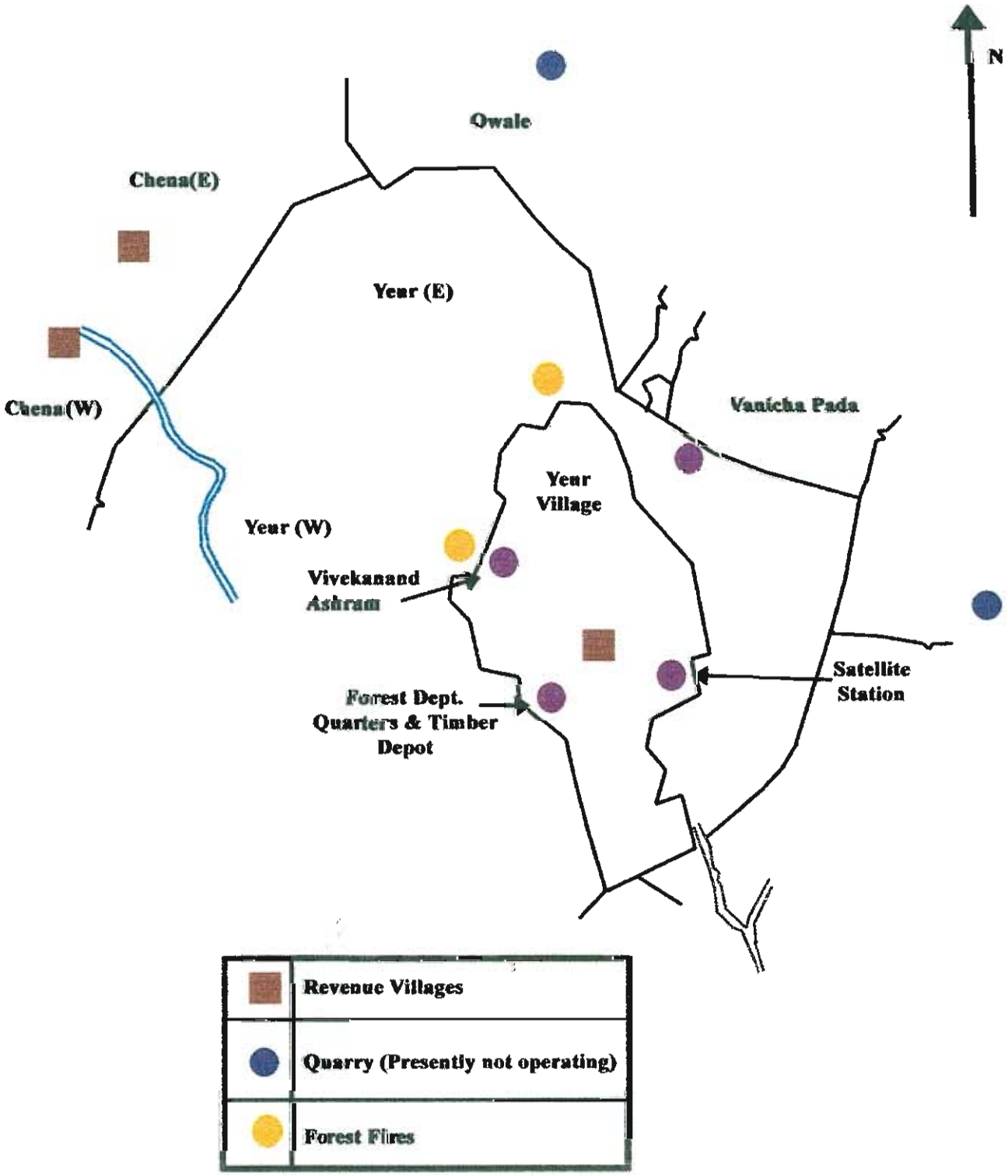


Map 6.4 Map showing problem areas visited in Malad Round

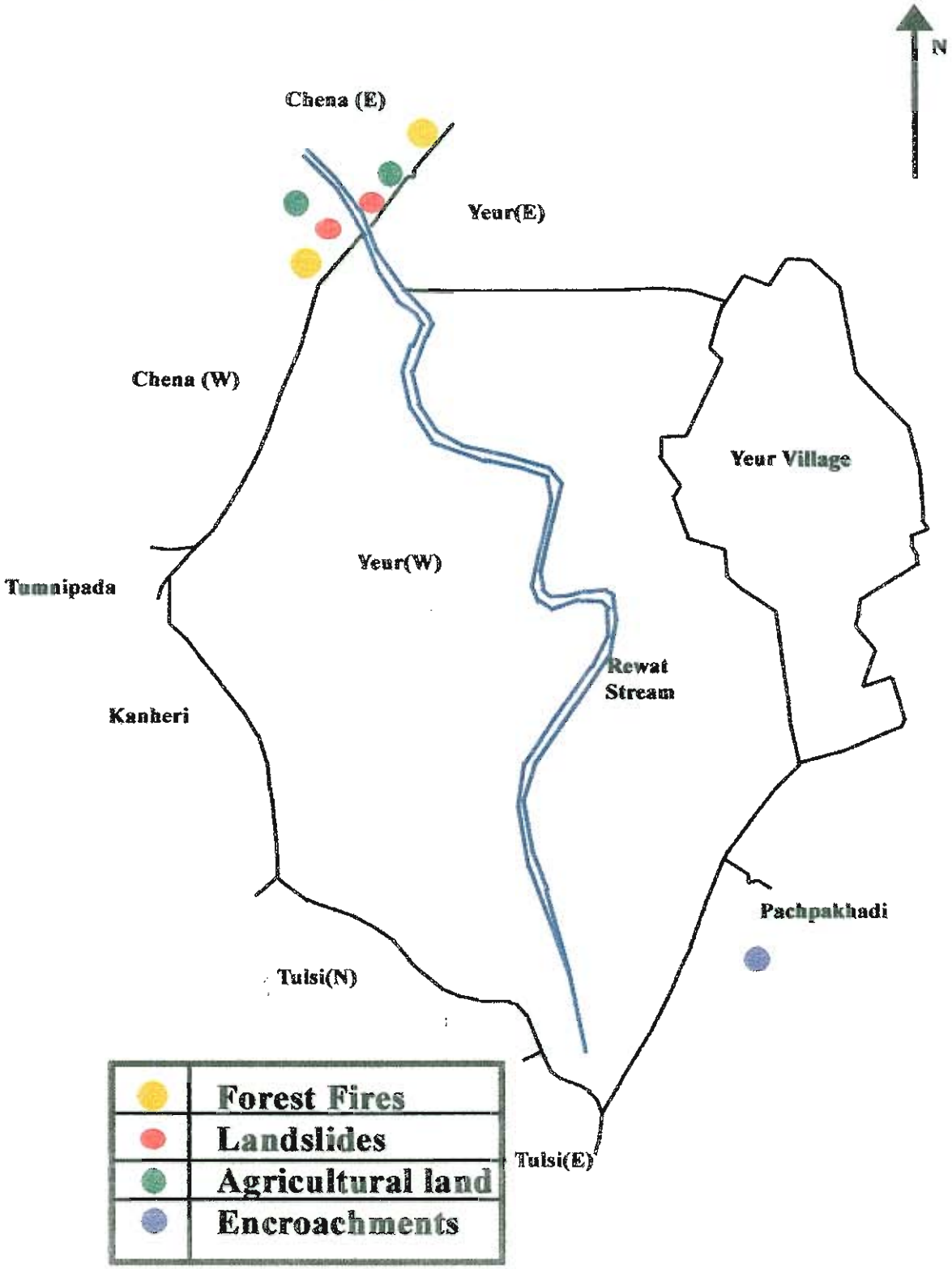
Map 6.5-Map showing Kawesar Beat of Yeur Round



Map 6.6-Map showing Yeur East Beat of Yeur Round



Map 6.7-Map showing problem areas in Yeur West beat of Yeur Round



CHAPTER 7 ENVIRONMENTAL MANAGEMENT PLAN FOR SANJAY GANDHI NATIONAL PARK

7.1 INTRODUCTION

The forests of the country are under tremendous pressure. On the one hand the poor are heavily dependent on the forests for their subsistence needs, on the other, the growing liberalisation, industrialisation and rapid increase of economic activities at the national and regional levels are putting pressure on the resource base. Over the years, country's forests have suffered serious depletion due to unrelenting pressure from increased demand for fuelwood, fodder, timber, inadequacy of protection and diversion of forestlands to agriculture and pastoral uses. As per the state of forests report of the Forest Survey of India (FSI 1999), the forest cover of the country is 63.73 million ha constituting 19.39% of the geographic area of the country, out of which 37.74 million ha (11.48%) is dense forest, 25.50 million ha (7.76%) open forest and 0.49 million ha (0.15%) mangroves.

In SGNP, as seen in the previous chapters, substantial degradation has occurred in park fringe and other areas due to encroachments, illegal felling of trees, forest fires, quarry operations etc. As per the 1999 State of Forest report of FSI, there has been a loss of about 17 sq. km. of forest area (including mangroves) in Mumbai over the last 3 years. The urgent need to rehabilitate and preserve these degraded areas cannot be overemphasized. The SGNP Division have been preparing Forest Management Plans in the past and the current Draft Management Plan (2000 to 2010), is a good effort to define various problematic issues with suggested action plans for the same.

The objective of this Environmental Management Plan (EMP) is limited to highlighting the environmental issues in SGNP area and providing action plans to tackle it successfully, while implementing the Forest management plan. This plan is supposed to supplement and not replace the existing Forest Management Plan for Sanjay Gandhi National Park

7.2 ECOLOGICAL IMPORTANCE OF FOREST AREAS

SGNP is spread over 103 sq.km. in the area of Mumbai and Thane City and constitutes about 13% of the area of these 2 cities. This tract of forested area imparts incalculable benefits to the residents of these cities and also contributes to global benefits to that extent.

Forests have many vital ecological functions, some of them are:

- Forest watersheds act as giant sponges, absorbing, holding and gradually releasing water that recharges springs, streams and acquifers. Degradation of water catchment areas result in soil erosion, silting of water resources and thus diminishing water resources.

- Forests play an important role in global carbon cycle and act as important defense against global warming by functioning as carbon sinks. CO_2 is known to be responsible for about 50% of the greenhouse gases in the atmosphere. Deforestation contributes indirectly to CO_2 increase as that much vegetation is not available for absorbing the CO_2.

- Forests provide habitats for a larger number of wildlife and plant species than any other land ecosystem, making them the planet's major reservoir of biological diversity. They also help buffer noise, absorb some air pollutants and nourish the human spirit by providing solitude and beauty.

  According to one estimate, a typical tree provides $ 196,250 worth of ecological benefits in the form of generation of oxygen, air pollution reduction, improvement of soil fertility, erosion control, water recycling, habitat and wildlife protection. Sold as timber the tree is worth only about $590. Ecological benefits are assigned little or no value in the world's market-oriented economic systems.

- Providing a healthy micro-climate of an area is achieved best by forests.

7.3 GOALS OF ENVIRONMENTAL MANAGEMENT PLAN

Goals of preservation of forest and national park areas should include:

- Preserve priceless natural beauty - SGNP is recognised for its picturesque landscape, its lakes and streams.
- Promote visitor understanding and enjoyment
- Improve and integrate information management systems to monitor forest conditions and treatments, to guide management practices and to monitor program efficiency.
- Initiate public participation processes to establish goals and promote awareness

In view of these goals and in consonance with the National Forest Policy, 1988 and the National Wildlife Action Plan, 1983, the objectives of wildlife management defined by SGNP Division are:

- To conserve key species of the area
- To protect Catchments of Tulsi and Vihar Lakes
- To conserve the Mangrove Ecosystem
- To remove encroachments and consolidate the external boundaries
- To provide nature education to visitors.

Problem areas in SGNP, which could have significant environmental impact, are discussed in **Chapter 6**. Various existing management practices by forest

department are also described in this chapter. Action plans and management strategy are discussed in this chapter for the following issues:

1. Protection of Lakes and their Catchment
2. Remediation of degraded areas such as encroached lands, MAFCO etc.
3. Abandoned quarry rehabilitation
4. EMP for existing quarries
5. Management of forest fires
6. Sustainable tourism
7. Improvement of residential areas inside park
8. Park security and surveillance.

7.4 MANAGEMENT of LAKES AND THEIR CATCHMENTS

7.4.1 General

Improving the ecology of lake is a laudable goal & the success of Lake Restoration projects should be measured on the basis of ecological criteria, not just on economic & human use criteria. Lake Management should promote a self-sustaining, stable system. Production & respiration should be roughly in balance, and the food web should be intricate enough to minimize uncontrolled growth and wild population swings by one or a few species. Species or genetic diversity is an important measure of ecosystem quality.

Stresses, which are responsible for degrading quality of lakes, in the present study are,

1) Excessive input of nutrient & organic matter leading to eutrophication (mainly Pawai lake)
2) Siltation, (Mainly in Powai and to some extent in Vihar lake)
3) Increase in macrophytes.(Powai lake)

In addition to actual restoration of lakes that have degraded by various means, it is essential to control the nutrient loading into the lakes from the surrounding watershed for long-term lake preservation. In order to do this, the catchment area needs to be studied to identify such sources of pollution/nutrients and steps to control such discharges needs to be implemented. In this vein, the catchment area also needs to be rehabilitated to prevent soil erosion, which causes siltation in lakes. Soil erosion and moisture conservation works also needs to be done for the entire Park, in addition to that for the lakes. SGNP division is already carrying out and planning more measures for soil and moisture conservation in the entire park area. Details regarding these are given in **Section 6.4.4 of Chapter 6.**

Action plans for improvement of Tulsi, Vihar and Powai lakes are given below:

7.4.2 Action Plan for Tulsi lake

Table 7.1 Action Plan for Tulsi Lake

Sr. No.	Action Plan	Responsible Agency
1.	Tulsi Lake catchment area is sufficiently well protected and can be considered as a control for any further evaluation of lake catchments. No further steps needed, except to ensure protection of the present state by way of regular surveys.	MCGM / SGNP Division

7.4.3 Action Plan for Vihar lake

As seen from water analysis, Vihar lake water does not need any remediation. However, the catchment area consists of many degraded patches. Also siltation of the lake due to soil erosion needs to be addressed. Plantation in the catchment consists of a high percentage of exotic species.

Table 7. 2 Action Plan for Vihar lake

Sr. No.	Action Plan	Responsible Agency
1.	Survey should be carried out to estimate vegetation cover. Areas need to be marked as follows – a. Satisfactory cover i.e. more than 60% area covered with vegetation, b. Medium cover – 20 to 60 % area covered with vegetation c. Poor cover – Less than 20 % area covered with vegetation	MCGM and SGNP Division
2.	Select the degraded areas for plantation	--- do----
3.	During plantation it is important to select local species of the area, as those found in Tulsi catchment. This would help in improving faunal biodiversity and in turn the water quality and soil conservation of the catchment of the lake.	--- do----

Sr. No.	Action Plan for Vihar lake	Responsible Agency
4.	Landscape the selected area for treatment such as stabilisation / protection / plantation – • contouring slopes of more than 25^0 with terraces 1m height and 2 –3 m width • Proceed for plantation on contoured areas. • Proceed directly for plantation on slopes of less than 25^0 . Ensure that all hill slopes are planted in successive five years with annual coverage of 20% of ground selected for the purpose.	MCGM and SGNP Division
5.	To reduce speed of runoff water plug gullies with stones every year.	--- do---
6.	Construct anticuts for retention of water in small to large water holes.	--- do---
7.	Dig pits on slopes or terraces for plantation of trees, store loose earth on slopes.	--- do---
8.	Plantation work should preferably be carried out in rainy season.	--- do---
9.	Plantation should be maintained by regular watering etc. especially during dry seasons.	--- do---
10.	No specific plantation is recommended along shores. Protection for 3 - 4 years will ensure adequate regeneration of right type of species.	--- do---
11.	To curb trespassing of slum dwellers to the lake for water use, security needs to be stepped up at the road connecting NITIE to Bhandup Complex. Water quality near Darga and Hanuman Tekdi have shown high levels of microbial contamination due to uses like bathing, washing etc.	MCGM
12.	Ensure that some types of plants do not grow on water (water hyacinth, Pistia, Duckweeds), in water (ceratophyllum) or along wet bank of lake (Hygrophila auriculata, Typha (elephant grass), Ipomoea carnea (Besharmi). If seen, remove the same immediately.	MCGM and SGNP Division

Responsibility for plantation can be shared between SGNP Forest Division and Municipal Corporation of Greater Mumbai (MCGM).

7.4.4 Action Plan for Powai lake

The catchment area of Powai Lake consists of a large percentage of built-up area consisting of residential and industrial pockets. Wastes from these areas, finds its way into the lake, thereby making the lake eutrophic. Apart from urgent lake remediation, these sources of waste discharge need to be identified and mapped comprehensively and steps are to be taken for their immediate control.

MCGM has received a grant for Powai Lake clean-up from the Ministry of Environment and Forests (MOEF) and lake cleaning is to begin shortly by MCGM. However, it should be ensured that a comprehensive action plan is drawn up before this task, which should include the following action steps:

Table 7.3 Action Plan for Powai lake

Sr. No.	Action Plan	Responsible Agency
1.	Identify all individual waste streams discharging into the lake and prepare and implement a plan for controlling and diverting / stopping such discharges. Characterisation of individual waste streams could also shed light on ways for their treatment and control. Pollutants of concern are nutrients such as phosphates and other organic and toxic material.	MCGM
2.	Lake water Remediation for improving the lake area. Various methods are available for this purpose and selection of the appropriate strategy for lake clean-up should be selected after a detailed study. Some strategies that could be considered are given below:	MCGM
3.	**Macrophyte Removal** – To remove the aquatic plants (floating) : Dense beds of plants alter the water chemistry & habitat structure leading to changes in invertebrate & fish communities & sediments. They have a low nutritive value to aquatic animals & provide a poor base for food chain.	MCGM
	Harvesters are used to remove macrophytes like water hyacinth, which have a high growth rate, however regrowth rate is so rapid that harvesting is largely impractical. Harvesting is only practical if the polluting sources are stopped.	MCGM

Sr. No.	Action Plan for Powai lake	Responsible Agency
	Bio-remediation – Fishes called Grass Carp *Ctenopharyngodon idella Val* is a herbivorous fish, which consumes a variety of plant species and are common biological control agents in different areas of the world. These fishes have voracious appetite for certain plants, if properly stocked, they are not likely to produce negative environmental impacts.	MCGM
	Sediment Removal – Dredging is useful to remove sediments laden with nutrients or contaminated with toxic materials at the bottom of lake.	MCGM
	Dissolved Oxygen Enrichment – Artificial aeration is a management practice to increase the dissolved oxygen content of the lake. Large aerators could be used to do so.	MCGM

7.5 MAFCO AREA REHABILITATION PLAN

MAFCO factory producing processed meat products has been operating for many years inside the park. As discussed earlier, due to the High Court order, it has now been stopped. Due to several years of effluent and solid waste disposal, the area surrounding the factory has become degraded with open effluent ponds, contaminated soil littered with animal carcasses and many patches of degraded forests.

This area is proposed to be rehabilitated by the Forest Department and be converted into a Nature Education Centre along with camping facilities.

Table 7.4 Action Plan for MAFCO area

Sr. No.	Action Plan	Responsible Agency
1.	Clean up and remediation of existing effluent ponds. These ponds can be used for development of water fountains. Area around the ponds to be developed into gardens.	SGNP
2.	Contaminated land to be cleaned up and remediated. Degraded land to be landscaped adequately.	SGNP
3.	Modification of existing facilities for developing Nature Education Center and lodging and boarding facilities. This should be developed as per plan prepared by Forest Department.	SGNP

7.6 REMEDIATION OF ENCROACHMENT AREAS

The managerial response to past and present deforestation is afforestation and intensification of forest protection and management. Large areas along SGNP periphery, which had been encroached by slum population, have now been demolished by Forest Department. Deforestation and other activities have degraded these stretches. Forest Department have already commenced plantation activities on these stretches and also construction of a boundary wall and other measures are being taken as per directive of the High Court. Details on these are given in **Chapter 6** of this report. Some suggestions on plantation that could be considered and integrated by Forest Department into the Plantation Plan are given below:

Table 7.5 Action Plan for Plantation

Sr. No.	Action Plan	Responsible Agency
1.	Remove all solid waste material left behind by encroachers such as rubble, bricks, wood, metal, glass, plastic, rubber, leather etc. Separate out non degradables for e.g. Plastic, metal, glass etc.	SGNP
2.	Crush rubble, brick and cement. Stock in lowlands and cover with about 15 cm layer of sweet earth. Leave it for a year for seasoning.	--- do---
3.	Plough back all monsoon growth in soil.	--- do---
4.	Dig pits at 5m intervals. Fill the same with red earth farmyard manure mix (3:1). Store surplus excavated earth on down slope side border of pit in a crescent shape.	--- do---
5.	Plant 3 year old healthy saplings of indigenous forest tree species in pits, during the first quarter of monsoon.	--- do---
6.	Use wild grass and herb as mulch.	--- do---
7.	Arrange to irrigate saplings during dry seasons, at the rate of twice a week in the first year, once a week in a second year and once a fortnight later on.	--- do---
8.	Replace weak or dead saplings as and when formed necessary.	--- do---
9.	Plant Agave in rows along contours of steep slopes (>25^0).	--- do---

7.7 QUARRY REHABILITATION

As discussed in **Chapter 6**, Shaikh quarry is one of the abandoned quarries where the past quarrying activities have created vast stretches of degraded land extending to quite a distance inside forest boundary at Dahisar. Restoration of such land by way of plantation and other techniques can transform the area dramatically. Short and long term benefits of improvement of such areas by way of increasing plantation include improvement of soil quality, binding of soil particles to check soil erosion, arresting dust emissions, noise barrier, supporting wild life, restoring bio diversity of the area and improving aesthetics.

To ameliorate objectionable and degraded conditions of quarried land following steps should be taken:

Table 7.6 Action Plan for Quarry Rehabilitation Area

Sr. No.	Action Plan	Responsible Agency
1.	Conceal, camouflage or reduce scars in ground made for quarrying.	SGNP
2.	Improve primary productivity by suitable plantation, thereby generate conditions conducive for attracting herbivores, avifauna etc. Plantation is to be done in the quarry pit area and also along the roads as avenue plantation. Details of species that could be planted are given in **Annex 3.1**	---do---
4.	Make the pits safe for use for recreational purposes. Following methods can be followed : • Landscaping to manipulate an artificial lake for rainwater storage. • Introduction of aquatic and semiaquatic plants. • Spiny and other repulsive bushes on the upper lips of the quarry border. • Trees and shrubs on upper ground. • Trees and shrubs on lower ground where soil is available. • Convert land into recreational site, e.g. playgrounds, open amphitheatres, jogging tracks, etc. • Stabilise slopes by landscaping, channelling runoff water, terracing etc. • Employ standard erosion control measures such as terracing, plantation on slopes and benches etc. using grass, Agave (Ghyapat) etc.	--do---

For this detailed working cost will depend upon location, size and shape of quarry and final utility option such as amenity, artificial forest, rock climbing and adventure sports, hiking, nature study area, bird habitat (lake, bushes & rock crevices),

recreation, non formal garden etc. As a thumb rule a shallow quarry (< 20-m depth) improvement may cost approximately Rupees 2.5 to 5 lakhs per acre.

A detailed Quarry Rehabilitation Plan should be made considering the above points.

7.8 ENVIRONMENTAL MANAGEMENT PLAN FOR EXISTING QUARRIES

As described in **Chapter 6**, the existing quarries along the park boundary have been observed to operate without much regard to environmental protection. Operations such as blasting, crushing of stone and haulage of material etc., are being done resulting in high loads of fugitive dust emissions, cracks in boundary walls due to blasting.

All authorised quarry operators should be made to follow good environmental management practices to mitigate negative impacts of quarrying on the forest and surrounding residential areas. Unauthorised operations should be closed down immediately. *The above tasks should be the responsibility of SGNP Division through the Indian Bureau of Mines, Director General of Mines Safety (DGMS) and the District Collector, whose office issues the quarry license.*

All quarry operators should prepare an Environmental Management Plan and mitigation measures for dust and noise should be implemented. **Essential features of an EMP for quarries are given in Annex 3.2.**

7.9 FOREST FIRE

Forest fires are a major cause of degradation of India's forests. While statistical data on fire loss are weak, it is estimated that the proportion of forest areas prone to forest fires annually ranges from 33% in some states to over 90% in others. In SGNP, 71 cases of forest fires were reported in the year 1998-99 which damaged about 340.02 Ha of forest standing crop. In SGNP the major cause of fire is man-made - mainly by encroachers and trespassers. As described in **Chapter 6**, current mechanisms of fire fighting include prevention methods of fire line construction, fire tracing and beating of fires by tree branches as a method of fire fighting.

A lot of improvement needs to be made in the fire fighting strategy including communication systems, transport and other infrastructure. As described in the Draft Forest Management Plan (2000-2010), several measures are proposed to be taken up for forest fire prevention and control, such as :

- Fire tracing
- Patrolling to control the entry of people in prohibited area
- Public awareness
- Sensitive beat guards will be provided 2 fire watchers each for fire fighting works from Feb. 15 to June 15 in each year

- To purchase modern forest fighting tools
- Training to the staff

These measures need to be implemented in a systematic fashion and a comprehensive **Forest Fire Management Plan** needs to be prepared. Such a plan shall include *analysis of current fire trends, fire prevention methods and preparing a dedicated fire prevention plan, fire detection and communication, preparation of fire response plans etc.* **Minimum essential issues to be addressed in a Forest Fire Management Plan are given in Annex 3.3.**

7.10 TOURISM

7.10.1 Introduction

One of the main functions of a National Park is to conserve the natural, wide gene pool of the bio-geographical region, represented in the protected area. Whereas absolute protection is the obvious way of facilitating conservation, it is often not practical in most places. Various zones such as Core Zone, Buffer Zone and Tourism Zone has been earmarked in SGNP and tourism is allowed only in the tourism zones. Tourism with an interpretative and educational objective also serves to increase awareness of the importance of protected areas and goes a long way in gathering public support against activities that can cause degradation of such areas.

As described in **Chapter 3**, SGNP has rich biological, archaeological and aesthetic values and has a tremendous potential for eco-tourism development. However, due to lack of trained manpower and paucity of funds for creating infrastructure for tourists, the park has not been able to realise its full potential of tourism. More details of such problems are given in **Chapter 6.**

7.10.2 Proposed Eco-Tourism Plan

The Conservator of Forests (Wildlife), SGNP has developed an **Eco-tourism and Conservation Plan** which aims at bridging the existing gaps in tourism development in SGNP. The plan has been developed with the major objectives of promoting awareness in visitors and general population of the importance of SGNP, creating a positive public image regarding the park and promoting recreation in the park without jeopardising wildlife and their habitat. The proposed plan has a total financial outlay of about Rs. 20 crores. Salient features of this plan are as follows:

Salient Features of Eco-Tourism Plan of Forest Department

Development of New Tourism Zones

Currently KUP is the only tourism zone in SGNP. Considering a large tourist influx (2 Million/year) 3 additional tourism zones are proposed. 2 zones in at the eastern

boundary at Manpada and Mulund and 1 zone at the north-western end at Kolai located at the edge of Vasai creek. The tourism zones will be developed to facilitate better opportunities for viewing wildlife and nature by way of canopy manipulation, developing view points etc.

Improvements in KUP Range

In order to make KUP range attractive, the following improvements are proposed by SGNP:

- ➔ Up-gradation of existing roads.
- ➔ Renovating existing rest houses
- ➔ Construction of public toilets
- ➔ Deepening and beautifying Dahisar River and Lake
- ➔ Redesigning and renovating animal cages
- ➔ Renovating the Mini train (Van Rani) and its tracks
- ➔ Providing additional parking places
- ➔ Renovation of gardens and development of children park

Developing Camping Sites

There are very few camping sites in the park and these too are in a dilapidated condition with no sanitary and other facilities for tourists. It is proposed to renovate these cottages and also upgrade infrastructure for camping by providing tents and other camping facilities.

MAFCO, the Pork Processing unit located inside KUP range has been closed down as per High Court ruling. The existing infrastructure of MAFCO is proposed to be converted and used as a camping and nature interpretation campus.

Improvement of Nature Trails

Existing nature trails are proposed to be improved by providing markers along the trails and preparation and distribution of brochures on train route details.

Up-gradation of Interpretation Centres

It is proposed to improve nature interpretation facilities inside the park and also spread public awareness about the park. For this purpose the following is proposed:

- ➔ Publication and distribution of information brochures, books, posters etc.
- ➔ Display of hoardings at public places such as airports, railway stations etc. to generate awareness.
- ➔ Display of maps and signages in the park with conservation messages and Do's and Don'ts etc.

Development of Human Resources

As discussed in Chapter 6, the current staff is not professionally trained for handling tourism or eco-tourism activity and for spreading awareness in an organised manner. Thus it is proposed to create a unit headed by the Range Officer (information Centre) dedicated for this purpose. This officer will be re-designated as Wildlife Tourism Officer and the unit headed by him will have trained nature guides.

Also local people living around the protected areas will be involved as guides to manage eco-tourism and also in the planning process of tourism activities. Corporate sponsorship for developing the above facilities is also being accepted by SGNP.

7.10.3 Suggestion During Implementation of Eco-Tourism Plan

As mentioned in the above plan, the tourists can be divided into 3 major categories such as picnicker's, Pilgrims and wildlife and nature enthusiasts. Majority of the visitors are in the first category who are mostly interested in recreation. A fourth type of tourism, that of Adventure tourism, also may be considered here.

All categories of tourists may visit specified areas, with due permission (and tickets at reasonable cost), with a clear understanding that they will follow a strict code of conduct, drawn in the interest of conservation. Some suggestions that can be considered by the Forest Department during implementation of the Eco-Tourism Plan are as follows –

Assimilative Capacity of SGNP

As given in Section 6.3.1, Chapter 6, tourism activity if unplanned can give rise to many environmental problems such as contamination from waste disposal, accidental forest fires, property damage etc.

Thus, before implementing the finalised tourism plan, due consideration should be made for assessing the carrying capacity of the area identified for tourism activity. The carrying capacity will depend upon various infrastructures to be planned such as Waste Management Facilities (Food wastes etc.), park security to manage the tourists, roads, parking spaces, sanitary facilities etc. All such facilities should be designed accordingly.

Eco-Tourists

- ➔ Groups of students and of public to be guided along well-demarcated trails, by guides who are well versed with their job and have proven capacity to relay to the party, information on different facets (structure as well as functions) of nature that they are visiting.
- ➔ Orientation courses for guides may be organised by the authorities.
- ➔ Apart from the Park staff, NGO participation in this aspect is a must, to ensure a more versatile approach to nature study by the public.

Adventure Tourists

- ➔ Small groups could move in specified areas suitable for trekking and rock climbing.
- ➔ Assistance from professionals in the field can be arranged by the park and will be of great value to guide a large number of youth anxious for this type of activity in schools and colleges in the city and elsewhere.

Religious pilgrims

- ➔ Groups of pilgrims shall go to specific destinations of religious interest.
- ➔ They shall be entertained to limited refreshments, etc. by authorised vendors in specific area at the destinations (only), on the days of special religious significance (only).

Recreation Visitors

- ➔ All types of visitors should be provided with easy-to-read maps to guide them in respective areas so as not to get lost in the wilderness.
- ➔ They should be exposed to a strict code of conduct (Do's and Don'ts) for observance within the Park premises.
- ➔ Easy-to-see landmarks on ground, or on trees lining the trails, trekking and pilgrimage routes may be tried. (e.g. Yellow metallic discs, 5" diameter, fixed to trunks of trees along the trails, at eye level, worked wonderfully well in the tropical rain forest at *Taman Negara* National Park in Malaysia)
- ➔ Park staff, assisted by NGOs, will remain vigilant about the activities of visitors to the Park. Do's and Don'ts in the Park will be strictly adhered to by all the visitors.
- ➔ All facilities, including permission to visit the Park will be charged at reasonable rates.

A list of Do's and Don'ts in the Park –

Do's	Don't
Report at the Entrance	Never visit the Park alone
Specify your interest in the visit	Do not forget to register and collect relevant map
Collect suitable route maps	Do not wander around the Park aimlessly
Carry essential water and refreshments	Do not litter the Park
Adhere to the directed routes	Do not disturb wildlife or pluck twigs, flowers, etc.
Always move in company	Do not forget to register your departure from the Park.
Carry your waste with you	
Report at the Exit	

7.11 RESIDENTIAL SETTLEMENTS

7.11.1 Solid Waste Management

Solid waste management is common problem in KUP and Yeur range where human settlements (Padas, revenue village and forest quarters) are more. Littering of domestic solid wastes such as plastic bags and garbage was observed near these settlements. **Photo 31** in Annex 4A depicts this situation. This creates unhygienic conditions and also erodes the aesthetic value of the area.

Table 7.7 Action Plan for Solid Waste Management

Sr. No.	Action Plan	Responsible Agency
1.	Prepare Solid waste management plan for handling solid waste. The plan should include the issues listed below:	SGNP
2.	*Segregation* Solid waste should be segregated at the source into non-biodegradable (Plastic, paper etc.) and bio- degradable wastes (vegetable matter etc.)	SGNP

	Storage • Non-biodegradable factions along with other scrap items to be stored in separate bins. This could then be sold as scrap. • Biodegradable waste to stored in covered bins. *Treatment* • Bio-degradable waste can be composted or vermi-composted and the manure can be utilized in gardens. • Non- biodegradable wastes such as plastic cans, bags, glass etc can be sold as scrap. *Collection and Disposal* Collection and disposal of leftover waste in municipal disposal grounds	Respective Municipal corporations such as MCGB, TMC.
3	Awareness on solid waste handling should be given to officials and population in villages.	SGNP

7.11.2 Forest Quarters

Quarters for forest officers are old dwellings and were found to be generally inadequate as compared to their counterparts for officers found outside in the city. These dwellings should be made better in order to improve the quality of life of Forest Officers.

7.12 PARK SECURITY AND SURVEILLANCE

Security and surveillance function in the park is very important to keep a check on disturbances such as encroachments, grazing, trespassers, detection and control of forest fires etc.

As discussed in Chapter 6, security in the park area needs a lot of improvement. Infrastructure such as communication (wireless sets), arms and ammunition for forest field staff, fast conveyance, watch towers etc. are totally inadequate and are major roadblocks hampering discharge of the security function by forest staff.

The above mentioned infrastructure should be upgraded urgently after determining specific needs and their priorities. Specific recommendations for upgrading communications network by MELTRON; up-gradation of arms and ammunitions by WWF; construction of boundary walls as per High Court orders etc., should be implemented as soon as possible.

7.13 PARK MONITORING

Environmental monitoring is an important on-going activity, which help in tracking environmental quality in a region or area. Baseline values for a variety of parameters for various ecosystems in SGNP were monitored as a part of this study and are presented in **Chapter 4**. Regular monitoring of these parameters at pre-determined locations and frequencies in the park is imperative for the following reasons:

- Tracking of health of the forest and its various ecosystems
- Taking timely action in case of any undesirable disturbances
- Planning of conservation measures from time to time.

The parameters and their frequencies of monitoring in SGNP were determined taking into account baseline values, disturbances observed and relative importance of the ecosystem. The following broad monitoring programs are envisaged in the park, which are described in more detail below:

- Vegetation and Soil
- Surface and Groundwater
- Air Quality and Noise

7.13.1 Monitoring Plan

The parameters, frequency of monitoring and location for monitoring are given in detail in **Annex 3.4(A).** The monitoring can be done by developing an in-house facility and laboratory in the Forest Department or by using third party laboratories.

Bio-monitoring, as part of the monitoring program is also recommended. Several of the parameters mentioned in **Annex 3.4(A)** could be monitored qualitatively using bio-indicators. These methods are less expensive in terms of time, labour and money, since they involves mainly field observations, with which forest department staff is well conversant. Bio-monitoring parameters and their monitoring frequency is given in **Annex 3.4(B)** and performa for monitoring the results are given in **Annex 3.4(C).**

7.14 Zone Development in SGNP

As per draft forest management plan for the year 2000 –10, the whole park division has been divided into 4 zones. This zonation has been done so as to prescribe suitable treatments for various types of areas of this division. Details about zones are presented in section 3.5 of Chapter 3.

The zonal plans give proposed measures to be implemented in each zone considering its use classification eg. The main objective in the Core Zone is to

provide complete protection to wildlife and to improve wildlife habitat. The programs for this purpose include steps for Prey base enrichment, grassland development, mangrove conservation etc. A summary of the proposed zonal plans is given in **Annex 3.5.**

7.15 PARK ENVIRONMENTAL MANAGEMENT SYSTEM

As observed in the previous chapters and sections, there are several objectives and goals, which are to be achieved by the Forest Department. To facilitate the achievement for these goals, it is suggested that a formal, documented system be developed. This system may be termed as the Park Environmental Management System. ***The main objective of this system would be to ensure continual improvement in the park environment.*** The system will be a voluntary mechanism on the part of Forest Department to systematically address various environmental concerns of the park. The documented system will also help in demonstrating to the outside world the efforts of the Forest Department towards ecological conservation and restoration.

The key ingredients of this system that could be adapted to suite the activities in SGNP are as follows:

a. Constitute a Core Team

A core team for overseeing implementation of various environmental measures in the park should be constituted. This core team could consist of: Park officials; External experts in various areas such as ecology and botany; Govt. and Non-Govt. agencies and other stake holders.

b. Define Policy and Objectives

This has already been defined by the Forest Department and is as follows:

- To conserve key species of the area
- To protect Catchments of Tulsi and Vihar Lakes
- To conserve the Mangrove Ecosystem
- To remove encroachments and consolidate the external boundaries
- To provide nature education to visitors.

c. Define Specific Targets and Action Plans

Based on objectives, the Forest Department has defined some programs or targets to be accomplished for various areas. Examples include the zonal plan in Annex 3.5, Eco-tourism plan etc. Plans for mitigating the various environmental impacts in the park area are also given by the consultants in the previous sections.

For effective implementation of these targets/programs the following tasks need to be carried out by the Forest Department:

- ➔ All programs / targets should be prioritized for implementation.
- ➔ Detailed action plans for implementing these programs to be documented in a suitable format. Issues to consider are:
  - Financial requirements and sanction
  - Define time frame of implementation
  - Designation of implementation team
  - Defining roles and responsibilities of team members

All the above should be documented for easy follow-up action.

d. Roles and Responsibilities

Roles and responsibilities at each level and function such as Conservator, Dy. Conservator, RFOs, Forest Officers etc. should be defined and documented. These would include specific responsibilities for various tasks such as environmental monitoring, specific tasks in each range, forest fire-fighting etc.

e. Training of Personnel

Training required for all personnel in the park for various functions should be identified and documented. This should include training for ecological and environmental awareness, forest fire prevention and control, forestry and wildlife management, safety and security etc.

The training staff (Internal or external) along with budget etc. should be determined and a phase wise training program should be developed for all employees. The entire program should be documented and the schedule of training should be maintained in a Training Calendar.

f. Developing Operation Procedures / Work Instructions

Work instructions and procedures for carrying out significant tasks such as fire fighting, wildlife management related tasks should be carefully drafted and documented. These instructions should be communicated to personnel performing these tasks (permanent or contract). This will help in assuring that all tasks are carried out as desired.

g. Monitoring and Records

Key characteristics of critical environmental components should be regularly monitored. An environmental monitoring plan for various eco-systems existing in the park is given in Section 7.11 above.

Parameters for tracking other important issues such as forest fire trends, animal health and statistics etc. should be defined and the frequency of monitoring, locations, responsibilities, methodology to be used etc. should be defined and documented. All monitoring results should be documented neatly in dedicated files.

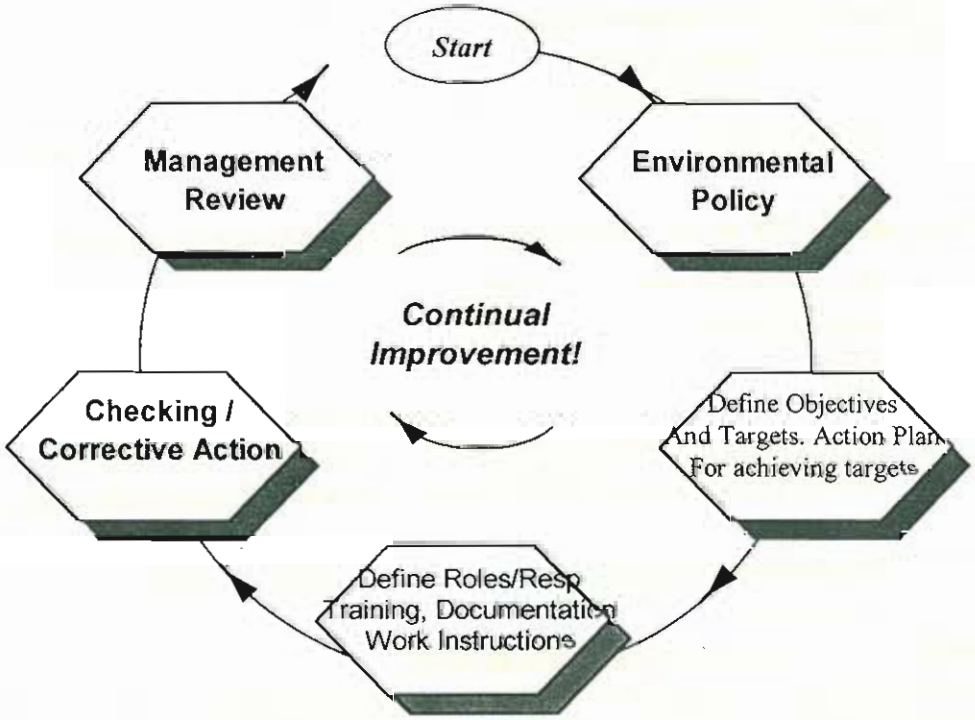
h. Audit and Reviews

This is one of the very important components of the management system. The **Core Team** should carry out annual review/audit of the status of implementation of all environmental programs, environmental monitoring programs etc. Reasons for non-implementation of certain programs as per target dates and other crucial environmental issues could then be tracked and action could be taken to mitigate such situations. The Core Team should assure that over the years, a positive continual environmental improvement is observed in SGNP.

An **Annual Management Plan Implementation Report** for SGNP should be prepared by the Forest Department, based on the annual review/audit. Also an overall **State of the Forest Report** for SGNP should be prepared after every 5 years to document the benefits accrued by implementation of various management plans.

A schematic of the Environmental management System is given in **Figure 7.1** below:

Figure 7.1 Environmental Management System Model for SGNP



7.16 Remote Sensing and Geographical Information System (GIS) for Park Management

The goal of a Geographical Information System (GIS) is to provide usable geographic data and information, through geographic information systems, for scientifically based management of park resources and for park planning. With GIS, park

managers have a powerful tool to solve resource management problems. The spatially referenced forest data on maps in a GIS allows park managers to bring together and relate information that otherwise would be impossible to integrate. The park manager can then discover changes, patterns, and trends in the resources.

Several efforts have been made to establish a GIS at State and National level in India. A GIS system for SGNP could be developed and integrated into the overall system.

Tasks of GIS administrator at the State Govt. or National Level will be to:

- Assist parks and programs in planning, developing, and implementing GIS technology
- Maintain liaisons between GIS efforts throughout the State/Nation
- Coordinate partnerships with other agencies and organizations
- Construct thematic data layers for parks
- Facilitate joint development of data with other agencies and organizations
- Provide GIS analysis of resource related issues
- Assist parks with data development and integration (e.g. collecting and importing GPS data into the GIS)
- Facilitate data exchange within and among park clusters and ecosystems
- Provide technical support for park GIS operations
- Provide GIS training to parks
- Provide services to develop GIS applications and products for parks and other programs including full services for parks without on-site GIS capabilities

Park staff (SGNP in this case) will perform the following functions:

- Manage daily computer system operations
- Coordinate data collection and documentation
- Develop databases
- Integrate, archive, and distribute data (data management)
- Perform GIS applications, analyses, and provide results to park managers
- Advise and assist park staff and partners with GIS applications and data development
- Facilitate and conduct training for park staff and partners

Action Plan for GIS Development in SGNP

Currently most records and databases in SGNP are not computerized. Basic computer facilities are not available for the staff. The following steps should be taken for computerization of data and developing GIS subsequently:

- Provide basic computer facilities, internet connectivity in park offices.
- Provide computer training to SGNP staff
- Computerization of database/inventory of various parameters in the park such as land use, forest density, extent of forest fires, plantation, deforestation, encroachment etc. and then referencing it spatially on maps.
- Integrating with GIS team at State and National level to develop a GIS for SGNP.

7.17 SGNP Improvement Program Financing Options

Currently revenues collected from Park activities such as Tiger Safari, Park entrance fees etc. is not utilized for maintenance of the Park. Government of Maharashtra apportions a fraction of this collection for Park maintenance.

State Government has recently abolished visitor entry fee for pedestrians. Vehicles are however charged at earlier rate. This has lead to a decrease in revenue for the park, which already has acute fund paucity. The earlier pedestrian entry fee of Rs. 2 was also considered to be very less. Also, this move has encouraged wanderers who treat the national park as any other park and do not care really for its beauty or benefits.

The following suggestions are made for sourcing of finance for environmental improvement of the park:

a. ***All funds collected from Park activities and entry fee, to be utilised solely for park management. To oversee and plan proper utilisation of these funds, a State Committee to be formed under the Chairmanship of Chief Conservator of Forests for approval of the plan for fund utilisation.***

b. ***Establish a dedicated trust wherein any donation from individuals and large corporations can be utilised for the betterment of the park. Provision to be made wherein any such donations will attract Income-Tax rebate.***

c. ***As seen in the previous sections, several; improvements are need for a wide variety of issues ranging from land rehabilitation to up-gradation of security in the park. Detailed projects reports with techno-commercial feasibility along with plan of implementation should be submitted to identified agencies for financial assistance. These agencies include multilateral funding institutions such as World Bank, Ministry of Environment and Forests, MMRDA etc.***

d. ***Large corporate organisations have also shown interest in sponsoring specific improvement programs in the park. Interest should be invoked in these Corporations for financing park activities and other improvement projects. Advertisement rights and other such benefits could be provided.***

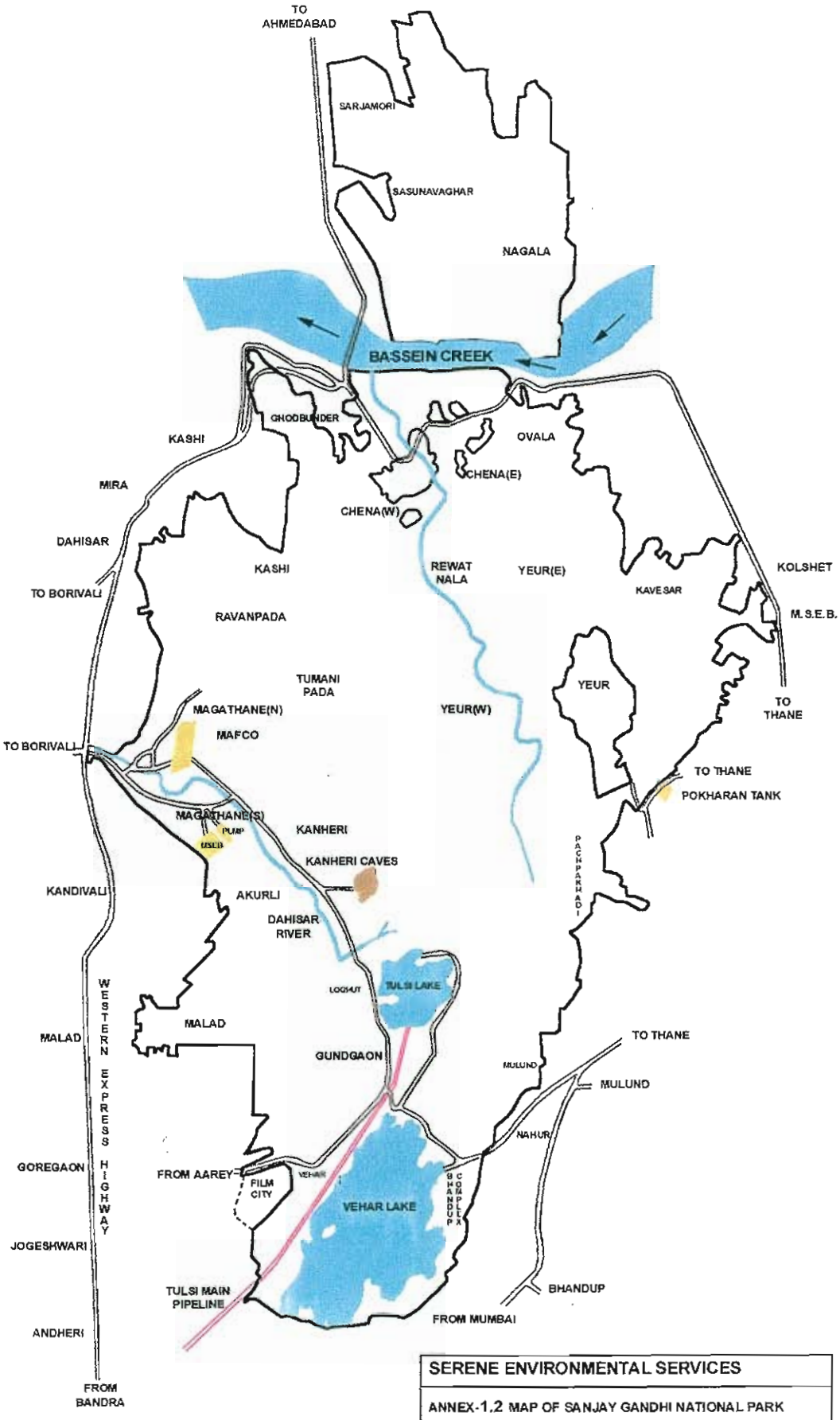
e. ***A study was conducted by Indira Gandhi Institute of Research and Development (IGIRD) on "Contingent valuation of Borivali National Park" in May, 1995. The focus of the study was willingness of Mumbai residents to pay for maintenance of SGNP. 500 residents in Mumbai from a variety of socio-economic backgrounds were interviewed. The study revealed that residents of Mumbai consider SGNP to be valuable enough to contribute towards its upkeep either in form of tax or as entry fees. It is recommended that the entry fee for pedestrians be re-instated and also revised upward significantly.***

f. ***It is also recommended that eco-tourism projects as per plan are taken on a fast-track and more publicity is given to the park to attract quality visitors. For this***

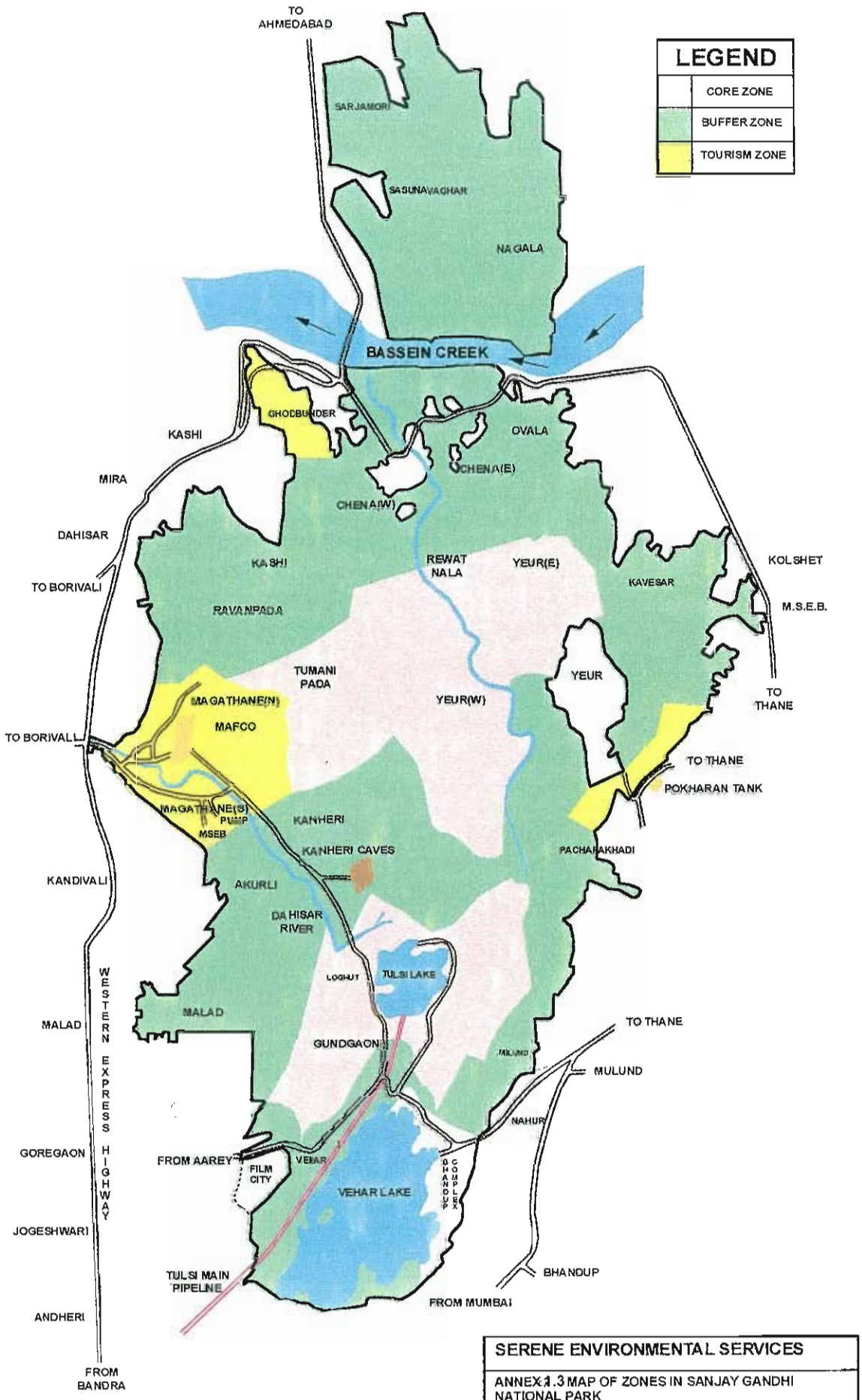
purpose active campaigns in the media (Radio, Television, print etc.) to be done for park promotion. A dedicated website can also be constructed for giving awareness about the park to the people which will help in invoking interest in park activities.

ANNEX

ANNEX 1.1-Location of Sanjay Gandhi National Park



SERENE ENVIRONMENTAL SERVICES
ANNEX-1.2 MAP OF SANJAY GANDHI NATIONAL PARK
CLIENT: MMR ENVIRONMENT IMPROVEMENT SOCIETY



SERENE ENVIRONMENTAL SERVICES
ANNEX 1.3 MAP OF ZONES IN SANJAY GANDHI NATIONAL PARK
CLIENT: MMR ENVIRONMENT IMPROVEMENT SOCIETY

ANNEX 1.4

(A) Floristics Composition of SGNP division

Sr.No.	Category	Botanical Name	Local Name
1	Trees	Adansonia digitata	Gorakh Chinch
2		Azadirachta indica	Kaduneem
3		Adina cordifolia	Haldu
4		Alstonia scholaris	Satwin, Satparni
5		Annona squamosa	Sitaphal
6		Annona reticulata	Ramphal
7		Anacardium occidentale	Kaju
8		Acacia arabica	Babul
9		Acacia catechu	Khair
10		Aegle marmelos	Bel
11		Anogeissus latifolia	Dhawda
12		Albizzia procera	Kinhai
13		Albizzia lebbek	Siris, Sankesar
14		Albizzia odoratissima	Chinchona
15		Albizzia chinensis	Pharadi
16		Acasia suma	Shenkhair
17		Atlantia racemosa	Ranilimbu
18		Acacia Ferruginea	Pandahra khair
19		Bombax malabarica	Sawar, Kate Sawar
20		Borassus Flabellifer	Tad
21		Bauhinia racemosa	Apta
22		Bauhinia variegata	Kanchan
23		Bridelia retusa	Asana
24		Bauhinia vahlii	Mahul
25		Bauhanaia lanzam	Charoli
26		Bauhinia malabarica	Ambotha
27		Barringtonia Acutagula	Nivar (Samudra-phal)
28		Butea monosperma	Palas
29		Cocos nucifera	Naral
30		Cassia fistuala	Arnaltas, Bahawa
31		Cordia myxa	Bhokar
32		Cyperus Spp.	Motha
33		Cordia macleodii	Daiwas (Dahivel)
34		Careya arborea	Kumbh
35	Trees	Casuarina equisetifolia	Suru
36		Calophyllum inophyllum	Undi
37		Dalbergia latifolia	Shisam
38		Delonix regia	Gulmohar
39		Diospyros melanoxylon	Tendu
40		Dalbergia paniculata	Dhobin

Sr.No.	Category	Botanical Name	Local Name
41		Dalbergia latifolia	Shisam
42		Dillenia pentagyna	Karambel
43		Dolichandrone falcata	Medsingi
44		Erythrina indica	Pangara
45		Ehretia laevis	Daterang
46		Euphorbia parviflora	Newali, Thor
47		Excoecaria agallocha	Phungali
48		Emblica O, Fficinalis	Awala
49		Elaeodendron glaucum	Jamrasi
50		Ficus tsiela	Pipar
51		Ficus arnottiana	Payer
52		Ficus bengalensis	Wad
53		Ficus mysorensis	Bhurwad
54		Ficus religiosa	Pimpal
55		Ficus elastica	Indian Caoutchuc
56		Ficus hispida	Kala Umber
57		Ficus glornerata	Umber
58		Ficus asperrima	Kharwat
59		Ficus retusa	Nandruk
60		Ficus heterophylla	Datir
61		Flacurtia Montana	Attak, Champer
62		Feronia elephantum	Kawath
63		Garcinia Indica	Kokarn
64		Garuga pinnata	Kakad
65		Grewia colimnaria	Kala Dhaman
66		Grewia tiliaefolia	Dhaman
67		Gardenia latefolia	Ghogari
68		Gmelina arborea	Shivan
69		Glycosmis pentaphylla	Kirmira
70		Holoptelea integrifolia	Valva, Papra
71		Hhmenodictyon excelsum	Potur
72		Holarrhena an-tidysenterica	Kuda
73		Heterophragma quadriculata	Warus, Panlag
74		Ixora arborea	Kuda
75		Ixora parviflora	Lokhandi
76		Ixora nigricance	Lokhandi
77	Trees	Jatropha curcus	Mogali, Erandi
78		Kydia calycina	Aranga
79		Lannea grandis	Shemat
80		Lagerstroemia parviflora	Bondara
81		Lagerstroemia lanceolata	Lendi
82		Mangifera indica	Amba
83		Madhuka indica	Mohwa
84		Manilcara hexandra	Ahmadabadi hewa

Sr.No.	Category	Botanical Name	Local Name
85		Mimnusops elengi	Bakul
86		Morida tinctoria	Shevaga
87		Macaranga peltata	Chandoda
88		Mitragyna parviflora	Kalamb
89		Memecylon edule	Anjani
90		Murraya koenigii	Kadulimb
91		Melia dubia	Bakan
92		Murraya exotica	Pandhari
93		Mimusops hexendra	Bakul
94		Mallotus phillipensis	Kamela, Kunku
95		Nyctanthes arbortristis	Parijatak
96		Ochrocarpus longifolius	Surangi
97		Oroxylum indicum	Tetav
98		Olea dioica	Par-Jambhul
99		Ougenia oojeinensis	Tiwas
100		Ptrocarpus marsupium	Bibla
101		Phoenix sylvesstris	Shindi
102		Pterospermum suberifolium	Konak Champa
103		Parkinsonia acutangula	Vedi-Babul
104		Pongamia pinatta	Karanj
105		Randia dumetorum	Gela
106		Ricinus communis	Erandi
107		Sterculia colorata	Khavas
108		Sterculia urenus	Khadhai
109		Saccopetalum tomentosumm	Humb
110		Syzygium cumini	Jambhul
111		Stereospermum personatum	Padal
112		Sapindus trifoliatus	Ritha
113		Semecarpus anacardiurn	Biba
114		Sesbania Grandiflora	Agasta
115		Salvadora parsica	Khakan
116		Strebulus asper	Kharota
117		Schleichera oleosa	Kusum
118		Spondias mangifera	Ambada
119	Trees	Sideroxylon tomentosum	Katekumbhal
120		Sterculia guttata	Kukeri
121		Tamarindus indica	Chinch
122		Terminallia bellerica	Behada
123		Terminallia tomentosa	Ain, Sadada
124		Terminallia arjuna	Argun
125		Terminallia chebula	Hirda
126		Tactona grandis	Sagwan
127		Trewia policarpa	Petari
128		Trema orintalis	Ran-Ambada, Korgol

Sr.No.	Category	Botanical Name	Local Name
129		Thespesia populnea	Ranbhendi
130		Vengueria spinosa	Alu
131		Wrightia tinctoria	Dudhi
132		Xylia xylocarpa	Jambu
133		Zizyphus jujuba	Bor
134		Zizyphus xylopyra	Ghatbor
135	Shrubs	Acacia pinnata	Shembati
136		Adathoda vasica	Adulsa
137		Asparagus racemosus	Shatawari
138		Acacia concinna	Shikekai
139		Amorphophallas campanulatus	-
140		Bambusa arundinacea	Bamboo (Katas)
141		Barleria prionitis	Korantaki
142		Capparis spinosa	Waghata
143		Capparis zeylanica	Waghati
144		Calycopteris floribunda	Ukshi
145		Carrisa carandus	Karwand
146		Calotropis gigantea	Rui
147		Clerodendron inerne	Koyanel
148		Crotolaria retusa	Ghogali
149		Eephorbia neriifolia	Nivdung
150		Erythropsis calorata	Khavas
151		Helicteres isora	Murudsheng
152		Ixora parviflora	Bakors
153		Jasminum pubescens	Ranmogra, Ranjai
154		Jatropha curcas	Chandrajyot
155		Kirganolis reticulata	Pavan
156		Leea edgeworthii	Dina
157		Lawsonia inermis	Mendi
158		Lepidagathis cristata	Kumbhi
159		Lantana camera	Ghaneri
160		Lantana alba	Gultora
161	Shrubs	Microcos paniculata	Shetali
162		Mayenia arecta	Alu
163		Moghania strobelifera	Kanfuti
164		Nerium indicum	Ran kanher
165		Opuntia dillenii	Nivdung
166		Oci mum canum	Ran tulas
167		Pogostemon purpuria	Pangali
168		Strobilanthus callosus	Karvi
169		Solanum indicum	Bhuj, Ringani
170		Vitex regundo	Nirgudi
171		Woodfordia floribunda	Dhayati
172		Zizyphus canoplia	Makor

Sr.No.	Category	Botanical Name	Local Name
173	Herbs	Agave americana	Ghaypat
174		Argemone mexicana	Pivla dhotra
175		Abutilon indicum	Mudra
176		Aeschynomene indica	Silar
177		Alysi carpus I ugosus	Baker
178		Ammania bacccifera	Bhar jambhul
179		Ammania multiflora	-
180		Anisomelis indica	-
181		Achyranthes aspera	Aghada
182		Alternanthera sessilis	Kancheri
183		Amairanthus spinosus	Kath-Math
184		Biophytum sensitivum	-
185		Begonia crenota	-
186		Bidens biternata	-
187		Blumea laciniata	Burada
188		Blepharis asperrima	-
189		Corchorus capsularis	-
190		Corchorus aestuans	-
191		Corchorus olitorius	Jute
192		Cardiospermum helicacabum	Kapsihodi
193		Cassia tora	Takla
194		Crotalaria juncea	Taag
195		Centala asiatica	-
196		Caesulia axillaris	Maka
197		Centrantherum anthelminticum	-
198		Centarium centaurioides	-
199		Coldenia procumbens	-
200		Commelina bengalensis	Kena
201		Commelina oblique	Kena
202		Curcuma aromatica	Jungali Halad
203		Desmodium trO, Florum	Ran Methi
204		Dinebra retrO, Flexa	Kardi
205		Datura kutal	Dhotra
206		Digera muricata	**Tanduliira**
207		Dioscorea bulbifera	-
208		Dioscorea pentaphyla	Babra
209		Eclipta alba	Maka
210		Elephantopus scaber	-
211		Evolvulus alsinoides	Shankavali
212		Euphoirbia hirta	Dudhi
213		Grangea maderaspatana	-
214		Hemidesmus indicus	Anant-Mul
215		Helianthus spp	Suryaphul
216		Hoppea dichotoma	-

Sr.No.	Category	Botanical Name	Local Name
217		Holitropium indicum	Bhurundi
218		Haplanthus tentaculatus	-
219		Hemigraphis latebrosa	-
220		Hygrophila serpyllum	-
221		IndigO, Fera astragalina	-
222		Impatiens balsamina	Terdi
223		Jussiaea suffruticosa	Ban Lavang
224		Justicia simplex	Sokamble Zara
225		Leea macrophylla	Dindi
226		Limnophila indica	-
227		Lindernia ciliata	-
228		Leucas aspera	-
229		Malachara rotundifolia	Ran Bhendi
230		Melochia corchorifolia	Methuri
231		Mollugo pentaphylla	-
232		Musa superba	Jungli-K
233		Oxalis latifolia	Khatta Zara
234		Oldenlandia corymbosa	Bit Papda
235		Portulaca oleracea	Ghola
236		Phaseolus radiatus	Mug. Moong
237		Phaseolus trilobus	-
238		Plumbago zeylanica	Shitrak
239		Physalia minima	Ran Popti
240		Peristiophe bicalyculata	-
241		Phyla nodiflora	-
242		Polygonum glabrum	Dongra
243		Phyllanthus niruri	Ran-Aoli
244		Pavetta indica	Papdi
245		Sida acuta	Jungli Methi
246		Sida retusa	Atibala
247		Smithea hirsuta	-
248		Smithea sensitiva	-
249		Sphaeranthus indicus	Gorkmundi
250		Solanum xanthocarpum	Bhuivangani
251		Sesamum indicum	Til
252		Stachytarpheta indica	Tuisi Zara
253		Strychnos nuxvomica	Kuchla
254		Scilla indica	-
255		Triumfetta annua	-
256		Triumfetta pilosa	-
257		Tephrosia purpurea	Sai-p Mukhc
258		Tridax procumbens	Degadipala
259		Trichodesma indicum	Ghotakalpa
260		Urena lobata	Jal-jaltang
261		Vernonia cineria	sahadevi
262		Waltheria indica	-

Sr.No.	Category	Botanical Name	Local Name
263		Woodfordia floribunda	Dhaiti
264		Xanthim strumarium	Gokharu
265	**Grasses**	Apluda mutica	Pochati, Fuli-Zara
266		Arundinella ciliata	-
267		Arundinella intricata	-
268		Arundinella minila	-
269		Andropogon triticus	Bhale Kusa
270		Andropogon monticola	Dongari Gavat
271		Andropogon pertusus	Ghanya Marvel
272		Andropogon pumilus	Gondval
273		Andropogon halepensis	Boru
274		Andropogon contortus	Kusali
275		Andropogon annulatus	Marvel
276		Andropogon schoenanthus	Rosha
277		Anthistiria ciliata	Bhongrut
278		Aristida paniculata	Bhuri
279		Brachiaria eruciformis	Sheprut
280		Coix aquatica	Ran jondhala
281		Cynodon dactylon	Hariyali, Durwa
282		Eleusine coracana	Nachni, Nagli
283		Eragrostis Spp	Darbha, Kusha
284		Imperata cylindrica	-
285		Ischaemum indicum	Ber
286		Ophismanus compositus	Hirvi Bangadi
287		Paspalidium flavidum	-
288		Panicum glabrum	Varai
289		Paspalum disticum	-
290		Spodiopogon rhizophorus	Math-zara
291		Sporobolus indicus	-
292		Themeda trianndra	Gondel
293	**Bamboos**	Bambusa arundinacea	Katas
294		Dendrocalarnus strictus	Manvel
295	**Climbers**	Ampelocissus latifolia	Kandvel, Rudrakshi
296		Abrus precatorius	Gunj
297		Argyreia nervosa	Samudra-Ashok
298		Argyreia sericea	Sambarvali
299		Butea superba	Palasvel
300		Capparis horrida	Tarati
301		Clematius triloba	Ranjai
302		Cocclus villosus	Parval
303		Cissus repanda	Arbatvel
304		Cissus auriculata	Kalivel
305		Cyclista scariosa	Ran Ghewada
306		Coccinia indica	Tondli
307		Caesalpinia sepiaria	Chillari
308		Celastrus paniculata	Malkangni, Pingvel

Sr.No.	Category	Botanical Name	Local Name
309		Capparis sepiaria	-
310		Combretum ovalifolium	Madhel
311		Derris trifolia	Kajarvel
312		Entada scandens	-
313		Gloriosa superba	Bachmag
314		Hemidesmus indicus	Anatvel
315		Ipomea digitata	Bhuikohala
316		Jasminum malbaricum	Jai
317		Luffa Acutangula	Shirali
318		Mucuna prurita	Khajkoyli
319		Momordica dioica	Kartoli
320		Marsdenia volubilis	-
321		Parsonia spiralis	Nagalkuda
322		Smilax zeylanica	Ghotvel
323		Tinospora cordidolia	Gulvel
324		Teramnus labialis	Ranudid
325		Trichosanthes palmata	Padval
326		Zizyphus rugosa	Torai
327	**Epiphytes**	Cuscuta reflexa	Amarvel
328		Dendrophthoe falcata	Bandgul
329		Viscum nepalensis	Banda
330		Vanda tessellata	Aitkel
331	**Aquatic plants**	Asteracantha longifolia	Kolshinda, Talimkhan
332		Cariops tagal	Chauri
333		Ipomoea aquatica	-
334		Limnanthemus indicum	Kumud
335		Murdannia nudiflora	-
336		Pistacia stratiotes	Gondal
337		Utricularia orbiculata	-
338	**Halobytes**	Aegierasorniulatum	Kunjala
339		Aanthusiliifolius	Marandi(Seaholly)
340		AienniaO, Ffiinalis	Tiar
341		Aienniamarina	Tiar
342		Pandanustetorius	Kewada
343		Sonneratiaapetala	Tiar
344	**Orhids**	Platantherespp	
345		Habernariaspp	

Source: Draft Forest Management Plan for SGNP (2000-2010)

(B) – Mammals of SGNP Division

Order	Family	Scientific Name	Common English Name
Insectivora	Pterodidae	*Suncus munnus*	House Shrew or Grey Musk
Chlroptera	Pterodidae	*Rousettus leschenaulti*	Fulvous Fruit Bat
		Pteropus	Indian Flying Fox
		Cynopterus sphix	Shortnosed Fruit Bat
	Emballonuridae	*Taphozous melanopogon*	Black-Beared Tomb Bat
		Taphozous soccolaimus	Pounch Bearing Bat
	Megadermatidae	*Megaderma spasma*	Malay False Vampire
		Megaderma iyra	Indian False Vampire
		Rhinolophus rouxi	Roux's Horseshoe Bat
		Hiposideros sperosis	Schenider's Leaf-nosed Bat
		Hipposideros bicolox	Bicoloured Leaf-nosed Bat
		Hipposiderous galeritus	Cantor's Leaf-nosed Bat
	Vespertilionldae	*Pipistrellus coromandra*	Indian Pipistrelle
		Pipistrellus minus	Indian Pigmy Pipistrelle
		Pipistrellus dormeri	Dormer's Bat
		Hesperoptenus tickelli	Indian Tickell's Bat
		Scotophilus heathi	Common Yellow Bat
		Kerivoula picta	Painted Bat
Primatos	Cercopithecidae	*Macaca radiata*	Bonnet Macaque
		Macaca mulata	Rhesus Macaque
		Presbytis entellus	Common Langur
Carnivora	Canidae	*Canis aureus*	Jackel
	Viverridae	*Viverricula Indica*	Small India Cavet
		Paradoxurus hermaphroditus	Toody Cat OR small India Civet
		Herpestes edwardsi	Indian grey mongoose
	Hyaenidae	*Hyaena hyaena*	Striped Hyaena
	Felidae	*Felis chaus*	Jungle cat
		Panthera pardus	Leopard
		Felis rubiginosa	Rusty Spotted Cat
Artiodactyla	Suidae	*Sus scrota*	Wild Boar
	Tragilidae	*Tragulus meminna*	Mouse Deer Or Indian Spotted Chevrotain
	Cervidae	*Axix axis*	Spotted deer
		Cervous unicolor	Sambar
		Muntiacus muntjac	Barking Deer or Muntjac
	Boridae	*Tetracerus quadncomis*	Fourthorned Antelope O, F Chevrotain
Lagomorphia	Leoporidae	*Lepus nigricollis*	Indian Black Naped Hare
Rodentia	Sciuridae	*Funambulus palmarum*	Three stripped Palm Squirrel
		Funambulus pennanti	Five Striped Palm Squirrel
		Hystrix indica	Indian Crested Porcupine
	Muridae	*Rattus blanfordi*	Whitened Wood Rat or Blanford's

Source: Draft Forest Management Plan for SGNP (2000-2010)

(C) Reptiles in SGNP

Order	Family	Scientific Name	Common English Name
Crocodilian	Crocodilian	Crocodiles palustriua	Indian marsh crocodile / Mugger
Restudies	Amyloidal	Geometer trigger trauma	Pond tortoises
	Testudindae	Tustudo elegans	Star tortoise
	Trionychidae	Trionyx lebthi	
Squamata	Gekkonidae	Hemida ctylus maculatus	Rock gekko
Sub-order - sauria		Hrmidactylus brook	Brok's gekko
		Hemidactylus leschenaulti	Bark Gekko
		Hemidactylus triedrus	Termite hill Gekko
		Eublepharis macularius	Fat Tailed Gekko
	Agamidae	Calotes versicolor	Common garden lizard or bloodsucker
		Calotes rouxi	Forest calotes
		Psmmophilus blanfordanus	Rock lizard
	Chamreleonidae	Chamaeleon zeylanicus	Indian chamaeleon
	Scinidae	Mabuya carinata	Common or brahminy skink
	Varanidae	Varanus monirtor	Common monitor
Sub-order – serpents	Typhlopidae	Typhlina bramina	Common worm or blind snake
	Boidae	Python moluxu	Indian python
		Eryx conicus	Russe's sand boa
		Eryx johni	Jhon's sand boa
	Colubridae	Acrochordus	Wart snake
		Elaphe Helena	Trinket snake
		Ptyas mucosus	Dharman or common rat snake
		Argypogena fasciolatus	Fasciolated rat snake or banded racer
		Argyrogena ventromaculata	Gray's rat snake or glossy bellied racer
		Oligoden arnonsis	Common kukri snake
		Dendrelaphis tristiis	Common Indian bronzeback or terr snake
		Lycodon travancoxicus	Travanccre wolf snake
		Lycodon aulicus	Common wolf snake
		Xenochrophis piscator	Checkered keelback
		Amphiesma stolata	Buffstripped keelback
		Macropisthodon plumbicolor	Green keelback
		Boiga trigonta	Indian gamma or cat snake
		Ahactulla nasutus	Common green whip snake
	Elapidae	Bungarus caeruleus	Common Indian krait
		Callophis malanurus	Slender coral snake
		Naja naja	Indian cobra
	Viperidae	Vipera russelli	Russell's viper
		Trimeresurus malabaricus	Malbar pit viper

Source: Draft Forest Management Plan for SGNP (2000-2010)

(D) Amphibians of SGNP division

CLASS –AMPHIBIA
ORDER- SALENTIA

No.	Family	Scientific name	Common English Name
1	Bufonidae	Bufo melanostictus	Common toad
2	Microhylidae	Mircohyla ornata	--
3		Ramanella montana	--
4	Ranidae	Rana cyanophlyetis	--
5		Rana limnocharis	--
6		Rana tigrina	--
7		Rana malabarica	-
8		Rana leithil	--
9	Rhacophroidae	Rhacophrus leucomystax	--

Source: Draft Forest Management Plan for SGNP (2000-2010)

(E) List of Birds in SGNP

Order	Family	Scientific name	Common English Name	Move -ment	Abun-dance
Podicipediformes	Podicipitidae-Grebes	Podiceps ruficollis capensis	Little Grebe or dabchick	R	O
Pelecaniforms	Phalacrocoracidae	Phalaerocorax niger	Little O, F Pigmy cormorant	R	C, F
		Anhinga rufa Melanogaster	Dartar	R	O
Clcomipormes	Ardeidae	Ardeola - gray	Pond Heron or paddy bird	R	C
		Bubulcus ibis, coromandus	Cattle egret	R	C, F
		Egretta alub modesta	Large Egret	R	U
		Elgrattca interrmedia intermedia	Median or Smaller Egret	R	O
		Egretta gazzetta gazzetta	Little egret	R	C
		Nicticorax nicticarax nicticorex	Night heron	R	U
		Ixobrychus cinnamomeus	Chestnut Bitters	R	U
	Ciconldae	Anastomus ositanas	Openbill stork	R	UF
		Ciconia episcopus episcopus	White Necked Stork	R	O, F
Anserjformes	Anatidae	Dendrocygna javanica	Lesser Whistling Teal	R	C, F
		Anus acuta	Pintail	M	C, F
		Anas creca creca	Common Teal	M	O, F
		Anas poecilorhyncha poecilor hyncha	Spotbill Duck	R	O, F
		Anas quercqueddula	Gazganey or Blue Winged Teal	M	C, F
		Aythaya ferina	Common or Redended Pochard	M	O, F
		Aythaya nyroca	White Eyed Pochard	M	C, F
		Aythaya fuligula	Tuffed Duck	M	C, F
		Nettapus coromandelianus coromandelianus	Cotton Teal	R	C, F
Falconiforces	Accipitridae	Elanus caeruleus viciferus	Black winged kite	RLM	O
		Pernis ptilorhyncus ruficollis	Crested Honey Buzzard	R	O
		Milvus migrans govinda	Pariah kite	R	C
		Haliastur Indus indus	Brahminy kite	R	O
		Accipiter badius dussumieri	Indian Shikara	R	C
		Accipiter trivirgatus	Crested Goshawk	R	U
		Accipiter nisus melaschistos	Sparrow Hawk	M	U
		Butastur teesa	Whied Eyed Buzzard	R	U
		Aquila rapex vindhina	Ta Wrry Eagle	LM	O
		Ictinactus Malayensis Perniger	Black Eagle	R	U
		Haliaeetus leucogaster	White Bellied Sea Eagle	R	O
		Gyps indicus indicus	Indian Longbilled Vulture	R	O, F
		Gyps bengalensis	Indian Whitebacked vulture	R	C, F
		Neophron Perenopterus	Indian Scavenger Vulture	R	O, F

Order	Family	Scientific name	Common English Name	Move -ment	Abun- dance
		Circus macrourus	Pale Harrier	M	O
		Circus pygarus	Montagus Harrier	M	O
		Spllornis cheela melanotis	Crested Serpent Eagle	R	O
		Panilon hatiaetus halieetus	Osprey	M	U
	Falconidae	Falco tinnunculus tinnunculus	European Kestrel	M	O
Galliformes	Phastanidae	Francolinus pictus	Painted patridge	R	C
		Cotumix Coturnix Cotumix	Common gray Queil	M	C, F
		Coturnix coromandelica	Blackbreasted or Rain Queil	M	C, F
		Perdicula asiatica asiatica	Jungle Bush Quail	R	C, F
		Galloperdix spadicea spadicea	Red Spurfoud	R	C, F
		Gallus Gallus	Red Jungle Fowl	R	U
		Gallus sonerratti	Grey Jungle Fowl	R	O
		Pavo cristatus	Common Peafowl	R	C, F
		Turnix sytvatica dussumier	Liggle Bustared Quail	R	U
		Turnix suscitator taigoor	Common Bustared Quail	R	C
	Rallidae	Rallus stviatus albiventer	Blue Brested Banded Rail	R	U
		Porxana pusilla pusilla	Baillon's Grake	M	U
		Porzane Porzane	Spotted Crake	M	O
		Amaurarnis phoenicurs phoenicurs	Whited brested waterhen	R	C
		Amaurornis fuscus zelonicus	Ruddy Crake	M	O
		Gallicrex chinerea chinerea	Water Cook or Kore	R	O
		Gallinula chloropus indica	moorhen	R	O
		Porphyrio porphyrio poliocephalus	Purple Moorhen	R	O
		Fulica atra atra	Coot	R	O, F
Charadriiformes	Jacanidae	Hydropha sianus chirurgus	Pheasant tailed Jacana	R	C
		Metopidulcus	Bronzewinged Jacana	R	C
		Haemtopus ostralegus	Dyster catcher	R	C
		Venellus indicus indicus	Red watted Lapwing	R	C
		Venellus malbaricus	Yellow watted Lapwing	R	O
		Numeniua phaeopus	Whimbrel	R	O
		Numeniua orquata	Curlew	R	O
		Tringa tetanus euthinus	Common Redshank	M	C, F
		Tringa stagnatills	Marsh sandpiper	M	U
		Tringa nebularia	Green shank	M	O
		Tringa ochropus	Green sand piper	M	C
		Tringa hupoleucos hypoleuccos	Common sand piper	M	C
		Gappela stanura	Pintail Snipe	M	C, F
		Gappela gallinego	Fantail Snipe	M	C, F
		Gappela minima	Jack Snipe	M	C, F
		Caldris minutus	Little stint	M	C, F
		Caldris temminickii	Temminck's stint	M	C, F
		Phlomachus pugnax	Rugt and Reeve	M	C, F

Order	Family	Scientific name	Common English Name	Move -ment	Abun- dance
	Rostratulidae	Rostratula benghalensis benghalensis	Painted shipe	R	O, F
	Recurvirostridae	Himantopus Himantopus Himantopus	Blackwinged stilt	MR	CF
	Burhinidae	Burhinus ocdicnemus	Stone curlew	M	O
	Glareeolldae	Cursorlus cocrmandellcus	Indian courser	M	O
	Lardiae	Larus brunnicephalus	Brounheaded Gull	M	C, F
		Larus brunnicephalus	Brounheaded Gulla	M	C, F
		Chlldonias bybrida indica	Whiskered Tern	LM	O, F
		Gelochelidon nilotica nilotica	Gullbilled Tern	LM	O, F
		Sterna aurantia	Indian River Tern	LM	O, F
		Sterna acuticauda	Blackbellied Tern	LM	O, F
		Sterna albifvons	Little Tern	M	O, F
Columbiforms	Ptercolidae	Petrocles exustus	Indian sandgrouse	M	O
	Columbidae	Treron pompadora affinis	Grey fronted Gveon	LM	O, F
		Treron pheonicoptera chlorigaster	Pigeon Yellow legged green pigeon	LM	O, F
		Columba livia intermedia	Blue Rock pigeon	R	C, F
		Streptopella decaocto	Indian Ring Dove	R	O
		Streptopella tranque baraca	Red Turtile Dove	R	O
		Stveptopelia chinensis suranternsis	Spotted dove	R	C
		Streptopila Senegalensis Cambayensis	Little Brown Dove	R	C
		Chalcophas indica indica	Emeraldd Dnvco	C	O
Psltlaclformes	Psittacidae	Pslttacula eupatria eupatria	Large Alexandrine Parakeet	LM	U
		Pslttacula krameri Manillensis	Roseringed Parakeet	R	C, F
		Pslttacula Cyanocephala Cyanocephala	Blossomheaded Prakeet	R	O, F
		Loriculuc vernalis	Indian Lorikeet	R	U
Cuculiformes	Cuculidae	Clamator Coromandus	Redwinged Crested	B.M	C
		Clamator Jacobinus serratus	Pied Crested Cuckoo	B.M	C
		Cuculus varius varius	Common Hawk, Cuckoo or Brain Fever Bird	M	O
		Cuculus Micropterus Micropterus	Indian Cuckoo	M	O
		Cuculus canorus	Cuckoo	M	O
		Cacomantis sonneratti sonneratti	Indian Baybanded Cuckoo	BM	O
		Cacomantis Merulinus passezinus	Indian plaintive Cuckoo	BM	O
		Surniculus lugubris dicruroides	Drongo Cuckoo	BN	O
		Eudynamys scolopacea scolopacea	Koel	R	C

Order	Family	Scientific name	Common English Name	Move -ment	Abun- dance
		Picoides mahraitensis mahraitensis	Yelloe fronted pied or Marathe Wood Peacker	R	O
		Picoides hunus hardwickil	Brownarouned Pygmy Wood Peacker	R	O
		Chrysocolaptes lucidus	Larget Golden Backed Wood Peacker	M	U
		Chrysocolaptes flstivus flstivus	black Backed Wood Peacker	R	U
PasserO, Fpres	Pittidae	Pitta brachyura brachyura	Indian Pitta	PM	RO
		Mirafra erythroptera	Redewiinged Bush tark	R	O
		Eremopterix grisea	Ashycrowned finch-lark	R	C
		Ammomanes phoenicurus pheoenicurus	Rufoustailed finch lark	R	C
		Galerida malabarica	Malbar Gestedlark	R	C
		Aluude gulgule gulgule	Small or Eastern Skylark	R	O
	Harundinidae	Hirundo concolar	Dusky Carg martin	M	C
		Hirundo rustica	Swallow	M	C, F
		Hirundo srnithii filifera	Wiretailed Swallow	R	O, F
		Hirundo dawrica nipalensis	Straited Swallow	M	C, F
		Hirundo dawrica erythropygia	Redrumped Swallow	R	O
	Lankidae	Lanius schach erythronotus	Rufous backed shrika	M	C
	Oriolldae	Oriolus Oriolus	Golden Oriode	LMR	C
		Oriolus xanthornus	Blackheaded onde	R	C
	Dicruidae	Dicrurus adsimilies macrocerus	Black Drongo or King Crow	R	C
		Dicrurus leucophaeus longicaudatus	Grey or Ashy Drongo	M	C
		Dicrurus aeneus aeneus	Bronzed Drongo	LM	C
		Dicrurus hottentottus hottentottus	Haircrested Drongo	RS	U
		Dicrurus paradiseus paradiseus	Large Racket tailed Drongo	R	O
	Artamidae	Artamus fascus	Ashy Swalloe shrike	R	O, F
	Sturnidae	Sturnus malabaricus malabaricus	Grey headed Myna	MR	O, F
		Stunus roseus	Rosy paster or Rosy starling	MR	O, F
		Sturnus contra contra	Pled Myna	R	O
		Acridotheres tristis tristis	Common Myna	R	C, F
		Acridotheres fuscus maharattensis	Jungle Myna	R	O, F
		Gracula religiosa indica	Gracke or Hill Myna	S	U
	Corvidae	Dendrocitta vagabunda vagabunda	Indian Tree Pie	R	O
		Corvus splendens splendens	House Crow	R	C, F

Order	Family	Scientific name	Common English Name	Move -ment	Abun- dance
		Taccocua leschenaultil	Sipkeer Cuckoo	R	C
		Centropus sinensis perrotl	Gow pheasant or coucal	R	C
Strlglforms	Strlgldae	Tyto alba stertens	Barn owl	R	O
		Otus scops	Scops owl	R	O
		Bubo bub	Great horned owl or eagle owl	R	O
		Bubo zeylonensis	Brown fish owl	R	U
		Glaucidlum radiatum radiatum	Barred jungle owlet	R	C
		Athene brama brama	Spotted owlet	R	C
		Also flammeus flammeus	Shorteared owl	M	O
Carrimulgiporns	Carrimulgidae	Caprlmulgus indicus indicus	Indian jungle Nightlar	R	O
		Caprimulgus asiaticus	Common Indian nightiar	R	O
Apodidae		Apus affinis affinis	House awiff	R	C.F
		Cypsiurus parvus batasiensis	Palm swiff	R	C.F
Trogonlformes	Trogonidae	Harpactes fasciatus legerli	Central Indian trogon or malabar trogon	R	U
Coractiformes	Alcodlnldae	Ceryle rudls	Lesser pied kingfisher	R	C
		Alcedo atthis taprobana	Small blue or common kingfisher	R	C
		Ceyx erithacus	Three toed kingfisher	R	C
		Halcyon smyrnesis fusca	White breasted kingfisher	R	C
		Halcyon plleata	Black capped kingfisher	L.M	C
	Meropidae	Merops phillppinus Phillppinus	Blue Tailed Bee-eater	P.M.	O, F
		Merops Orientails Orientails	Green Bee-eater	LM	C
	Coracudae	Coraclas benghalensis indica	Indian Roller or Blue Jay	LM	C
	Upupidae	Upupa-Epops	Hoopoe	M	C
	Bucrotidae	Tockus griseus	Malbar Indian Grey Hornbill	R	O
Pictformes	Capitonidae	Megalaima Zeyianica inornata	Large Green Barbet	R	C
	Picidae	Megalaima huemacephaia indica	Crimsonbreasted Barbet or Copper smith	R	C
		Jynx torquilla torquilla	Wryeck	M	O
		Micropternusbrahyurusjerdo nil	Rufous Wood Pecked	R	C
		Dinopun benghalense tehminae	Lesser Gold Backed Wood Peacker	R	C
		Dinoplum Javanense	Indian Goldenbacker Three Toed Wood Peacker	R	C
		DryocopusJavensis	Indian Great black Wood Peacker	R	O

Order	Family	Scientific name	Common English Name	Move-ment	Abun-dance
		Corvus macrorhynahos culminatus	Jungle Crow	R	C
		Coracina melanoptera sykesi	Blackheaded cuchooshrike	R	C
		Pericrocotus flammeus	Scarlet minivet	R	O
		Pericrocotus clnnamomeus	Small Minivet	R	C, F
	Trenidae	Aegithina tipha multiculor	Common lora	R	C
		Chloropsis aurifrons frontalis	Gold fronted choropsis	R	O
		Chloropsis cochinchinensi jerdoni	Jerdons or Goldmantled chlopasis	R	O
	Pycononotidae	PyclononO, Fus jocosus fuscicaudatus	Redwhiskered Bilbul	R	C
		Pycononotus leucogenys leucotis	White eared Bulbul	R	U
		Pycononotus cafer cafer	Redvented Bulbul	R	C
		Pycononotus luteolus luteolus	White browed Bulbul	R	O
	Muscicapidae	Pellorneum ruficops ruficops	Spotted Babbler	R	C, F
	Sub-family-Timallnae	Pormstarhlnus schisticeps horefleldii	Slaty headed Scimitar Babbler	R	O
		Dumetia hypazythra	Rufous bellied babbler	R	C
		Chrysomma sinense siense	Yelloweyed Babbler	R	C, F
		Turdoides caudatus	Common Babbler	R	C
		Turdoides maicoiml	Large Grey Babbler	R	C
		Turdoies striatus	Jungle Babbler	R	C
		Aicippe poloicephala	Quaker Babbler	R	C, F
	Sub-family-Musciapinae	Musciapinae pazva parva	Western Redbreasted flycatcher	M	O
		Musciacapa tickelliae thickialliae	Tickells Blue flycatcher	LM	O
		Musciacapa thalassina thalassina	Verditer flycatcher	M	O
		Musciacapa letirostvs	Brown Flycatcher	LM	O
		Cullcicape ceyionensis calochrysea	Grey headed flycatcher	M	O
		Rhipidura albicollis albogularis	White spotted fantail	R	C
		Terpsiphorie paradisl paradisl	paradise flycatcher	MR	O
		Monarcha azurea styani	Blacknaped flycatcher	M	O
	Sub-family-Sytviinae	Cisticola juncidis cursitans	Stveaked fantail warbler	BM	O
		Prinia hodgsonni hodgsonni	Franktin's wren warbler	R	C
		Prinia subflava inarnata	Plain wren warbler	R	C
		Prinia socialis socialis	Ashy wren warbler	R	C
		Prinia sytvatica	Jungle wren warbler	R	C
		Orthotornus sutorius gusuraus	Tailor Bird	R	C

Order	Family	Scientific name	Common English Name	Move -ment	Abun-dance
		Acrocephalus stentoresus brunnescens	Indian Great Reed warbler	MR	O
		Acrocephalus dumetorum	Blyth's Reed warbler	M	C
		Acrocephalus aqricola	Paddyfield warbler	M	O
		Hippoleis caligata caligata	Booted Treewarbler	M	O
		Syivia curruca blythi	Lasser whitethroat	M	O
		Phylloscopus collybita	Brown leafwarbler or chiffchaff	M	O
		Phylloscopus tytieri	Tytler's leas warbler	M	O
		Phylloscopus inornatus	Yellow browed leaf warbler	M	O
		Phylloscopus biochiloides viridanus	Dull Green Leaf Warbler	M	O
	Sub-family-Turdinae	Erithacus avecicus	Blue throat	M	C
		Copsychus saularis saularis	Magpie Robin	R	C
		Copsychus Malabaricus Malabaricus	Shama	R	O
		Saxicola torquata indica	Stone chat	M	O
		Oenanther deserti	Desert chat	M	O
		Saxicoloides fulicata intermedia	Indian Robin	R	C
		Monticola Cinclothynchus	Blue headed Rock Thrush	M	O
		Monticola Solltarius pandoo	Blue headed Rock Thrush	M	O
		Myiophonus horsfieldii horsfieldii	Malabar whistingThrush	R	C
		Zoothera Citrina cyanotus	White throated Ground Thrush	R	O
		Turdus herula Nigropiieus	Blackbird or Black caped	LM	O
	Family – Motacillidae	Anthus trivialis trivialis	Tree Pipit	M	C, F
		Anthus godlewskil	Blythe Pipit	M	O, F
		Motacilla citreola citreola	Yellow headed Wagtail	M	C, F
		Motacilla alba dukhunensis	White or pide Wagtail	M	C, F
		Dicaeum ezythrorhynchos ezythrorhynchos	Tickells flower	R	C
		Dicaeum agile agile	Thickbilled flower pecker	R	O
	Family – Nectarinidae	Nectarinia Zeyionica sola	Purplerumped sunbird	R	C
		Nectarinia iotenia hindustanica	Lotn's sunbird	R	O
		Nectarinia asiatica asiatica	Purple sunbird	R	C
		Aethopyga siparaja vigorsii	Yellow backed sunbird	R	U
	Family – Ploceidae	Passer domesticus indicus	House Sparrow	R	C, F
	Sub-Family – Passerinae	Petonia xanthocllis zanthocllis	Yellow throated Sparrow	R	C, F
	Sub- Family – Pioceinae	Pioceus phillippinus phillippinus	Baya or weaver Bird	BM	C, F
		Estrilda amandava amandava	Red Munid or Avadavat	R	O, F

Order	Family	Scientific name	Common English Name	Move -ment	Abun- dance
		Lonchura malabarica malabarica	White throted Munia	R	C, F
		Lonchura striata striata	White backed Munia	R	C
		Lonchura Punetulata punetulata	Spotted Munia	R	C, F
		Lonchura Malacca malacca	Blackheaded Munia	R	O, F
	Family - Fringiiidae	Carpodacuserythrinus roseatus	Common Rosefinch or Scarlet Grosbeak	M	C, F
		Emberiza melanoc eahala	Blackeaded Bunting	M	C, F

Abbreviations -

R*	Resident
M	Winter Migrant
MR	Migrant But Some Breed Here
LM	Local Migrant
BM	Breeding Migrant
PM	Passage Migrant
S	Stray or Vagrant
RS	Stray Recorda(s) But Resident In Neighbouring areas
C	Common
O	Occasional
U	Uncommon
F	In Parties or Flocks

Source: Draft Forest Management Plan for SGNP (2000-2010)

(F) List of Moths Recorded During 1994 -96

Sr. No.	Family	Sub – family	Name O, F the Species
1.	Saturnidae	-	Actias selene (Hubner)
2.			Antheraea paphia (Linnaeus)
3.	Sphingidae	Sphinginae	Acherontia lachesis (Fabricius, 1978)
4.			Clanis phalaris (Hubner)
5.			Polyptychus dentatus (Cramer)
6.			Marumba dyras (Butler, 1875)
7.		Macroglossinae	Cephonodes hylas (Linnaeus, 1771)
8.			Nephele didyma (Fabricius, 1775)
9.			Gurelca hyas (Walker, 1865)
10.			Macroglossum gyrams (Walker, 1865)
11.			Macroglossum belis (Cramer)
12.			Theretra clotho (Drury, 1773)
13.			Theretra alecto (Linnaeus, 1758)
14.			Theretra lycetus (Cramer, 1775)
15.			Theretra oldenlandiae (Fabricius, 1775)
16.			Rhyncholaba acteus (Cramer, 1779)

Source: Ph.D. Thesis on " Ecology O, F Moths O, F SGNP with special reference to moths belonging to family Saturnidae and Sphingidae" by V. Shubhalaxmi, BNHS, 1997.

(G) – Prominent Marine Fishes of the Bassein Creek

Sr. No.	Scientific Name	Local Name	English Name
1	Hilsa ilisha	Paia	Indian Shad
2	Hilsa toli	Bhing modar	Giant Harring
3	Therapon jarbaa	Mavapa , nayanda	Target Parch
4	Epinephalus maculatus	Hekru	Spotted Grouper
5	Mugil cephalus	Boi, pilas	Mullet
6	Mugil speiglieri	Boi, hadvi	Mullet
7	Mugil engeli	Boi	Mullet
8	Harpodon nehereus	Bombil	Bombay duck
9	Spams berda	Khadak balu	Black sea Bream
10	Scatophagus argus	Vada	Seat
11	Tachysurus sps.	Shingala	Cat Fish
12	Coilia dussumieri	Mandeli	Golden Anchoy
13	Boleophthalmus sps.	Nivti	Mudskippers
14	Megalope cyprinouides	Vadas	Big – eye
15	Eleutheronema	Rawas	Thread fins
16	Penacus sps.	Kolambi	Prawns
17	Actes sps.	Karali	Shrimps
18	Pampus argentus	Poplet	Pomfret
19	Muraenosx sps.	Wam	Eel
20	Trichiurus sps.	Vagti	Ribbon Fish
21	Thxissocles sps.	Kati	Clupied
22	Chirocentrus sps.	Datal	Silver bar
23	Sciaenidae family	Dhoma	Jow fish
24	Otolithus sps.	Dhoma	Croaker
25	Bregma ceros	Tendli	Fam Gadida

Source: Draft Forest Management Plan for SGNP (2000-2010)

(H) PROMINENT FRESH WATER FISHES IN THE PARK

Sr. No.	Scientific Name	Local Name	English Name
1	Basbora diniconium	Daudavan	Rasbora
2	Barbus sareha	Darai or khaval	Olive crap
3	Discongnchus lanta	Nullya	Stone Carp
4	Seccobranchus fossilis	Nal singali	Stinging Cat fish
5	Aystus gulic	Shingala	Cat fish
6	Chana gachus	Dhokh, Daku	Murrel
7	Gobius giupeoides	Kharabi	Fresh water Goby
8	Chela clupeoides	Chilwa	Chilwa
9	Catla catla	Catla	Major Carp
10	Labeo rohita	Rohu	Major Carp
11	Cirrhina mrigala	Mriga	Major Carp
12	Wallago attu	Shivda	Wallago
13	Natopterus sps.	Chalat	Feather back
14	Puntins sps,	Khavlya khavel	Carps
15	Megalops sps	Vadas	Big-eye
16	Latea sps.	Khajura	Coci-up
17	Tilapia sps.	Tilepia	Tilepia
18	Etroplus sps.	Kalunder	Pearl Spot

Source: Draft Forest Management Plan for SGNP (2000-2010)

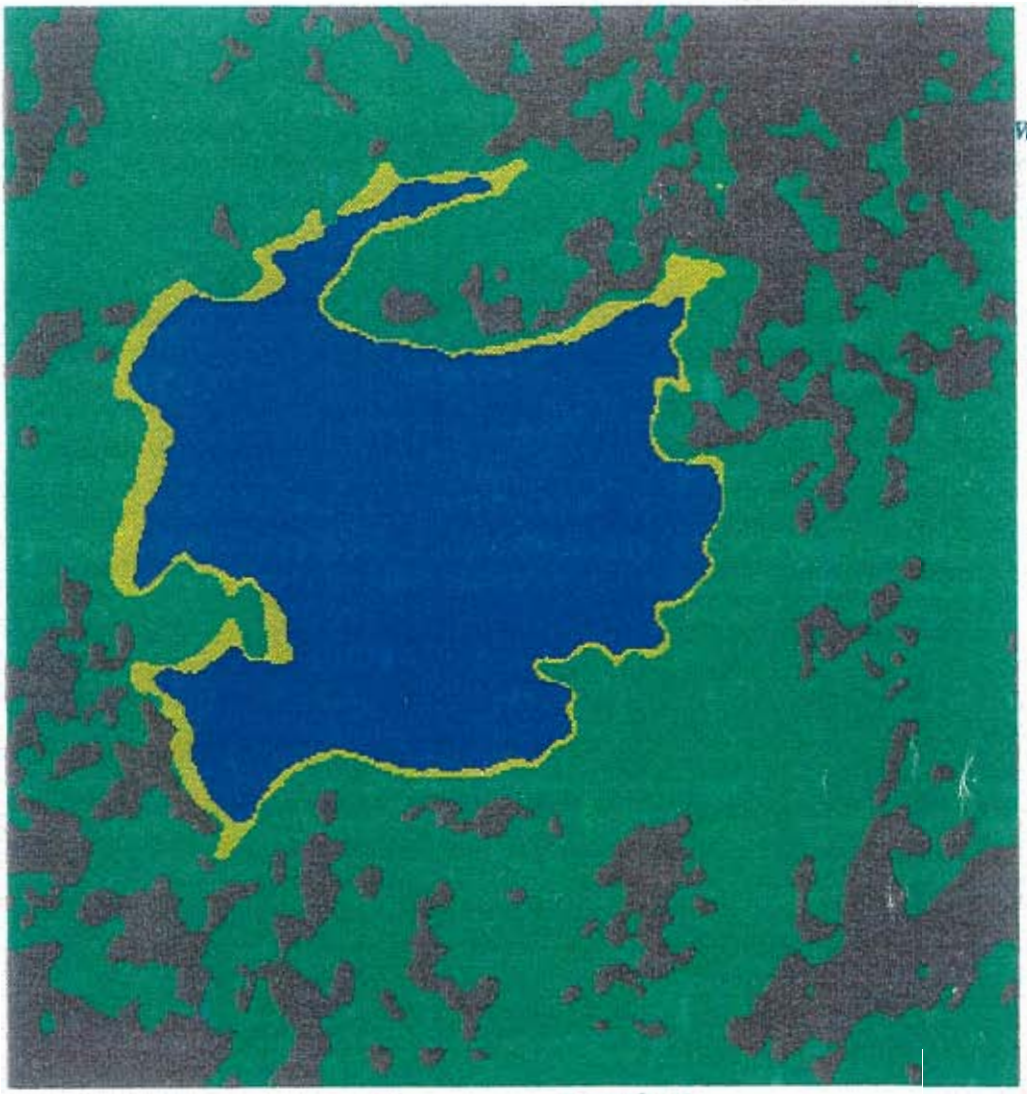
ANNEX 1.5 MORPHOLOGY OF VEHAR, TULSI AND POWAI LAKES

No.	Characteristics	Vehar lake	Tulsi lake	Powai
1.	Distance from Mumbai town Hall in miles	18	22	17
2.	Year O, F commissioning	1859	1879	1890
3.	Lake Depth – Maximum meter Minimum meter	33.95 12.0	17.46 8.10	
4.	Water spread area in sq. km.	7.26	1.35	2.10
5.	Catchment area in sq. km.	18.96	6.76	6.68
6.	Useful contents in megalit.	5929.9	20631.8	
7.	No. and type O, F dam	Earthen in 3 sections	Masonry & earthen	Masonry
8.	Total length O, F dam in ft.	2326	2758	650
9.	Max. height O, F dam in ft.	89,42 & 49	90, 35 & 20	30
10.	Full supply level in THD in ft.	264.75	456.6	195
11.	Gross storage at FSL in million gallons	9200	2294	1200
12.	Safe drawable level in THD in ft.	242.5	432	--
13.	Lowest water level in THD in ft.	230.50	397.75	175
14.	Outlet levels in THD in ft.	1. 254.50 2. 246.50 3. 238.50 4. 230.50	1. 448.50 2. 438.50 3. 424.91 4. 397.75	1. 190 2. 185 3. 175
15.	Average annual loss O, F water in Mg.	830	192	223
16.	Loss / day in Mg. Due to evaporation & other losses	4	2	-
17.	Quantity O, F water supplied to greater Mumbai in MGD	12	4	Non potable purpose
18.	Conveyance system	48" CI main	27" CI main upto Tulsi filters and 24" there after	24" A.C.pipe.

Source: MCGB – Hydraulics Dept.

ANNEX-1.6(a)

LAND USE AROUND TULSI LAKE



Legend Title

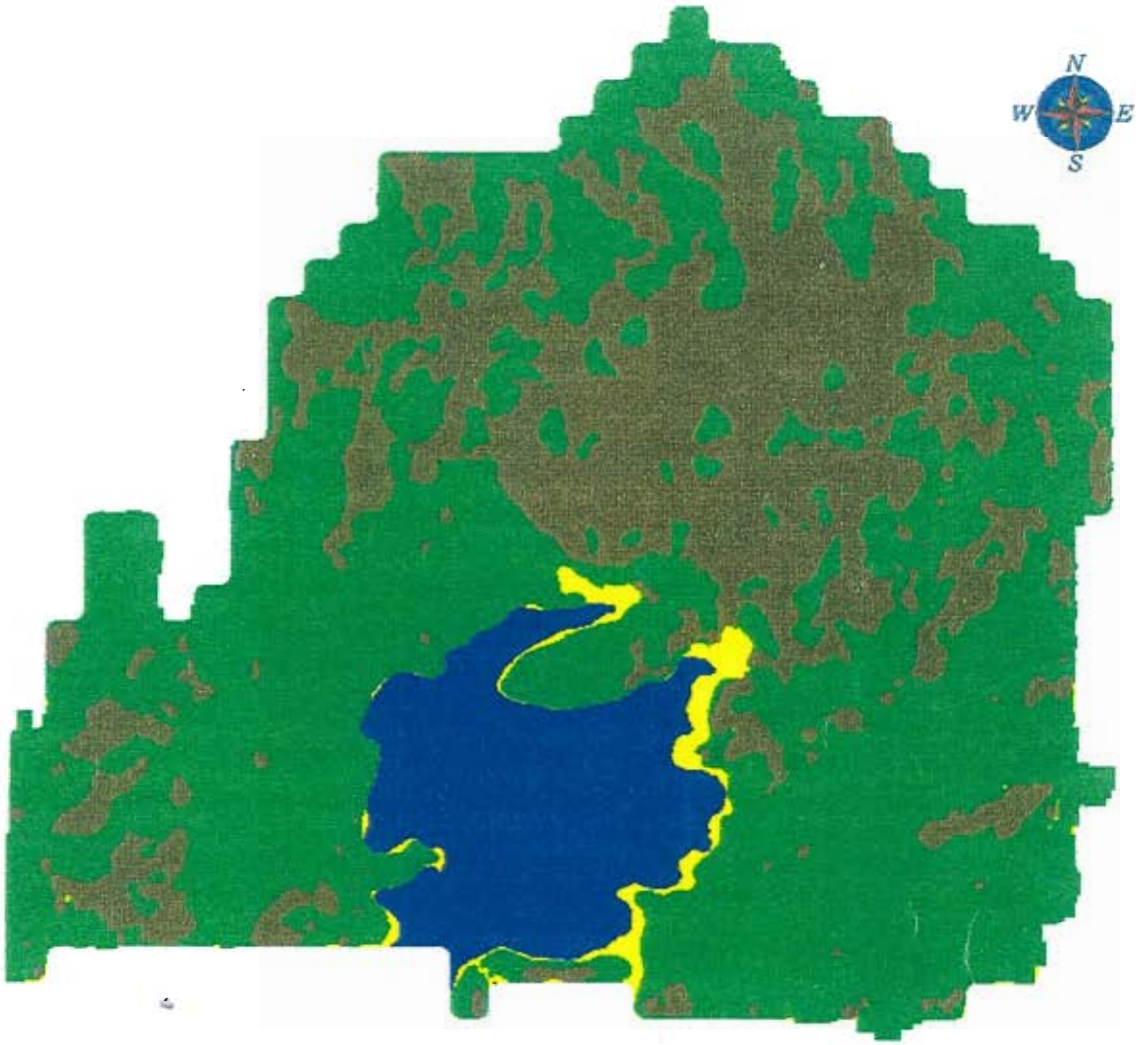
WATER BODIES	
SHORE LINE VEGETATION	
FOREST	
DRY (OPEN) FOREST	

Scale 1:20000

Metre 50 0 50 100150 Metre

ANNEX- 1.6(b)

LAND USE MAP OF TULSI LAKE CATCHMENT AREA



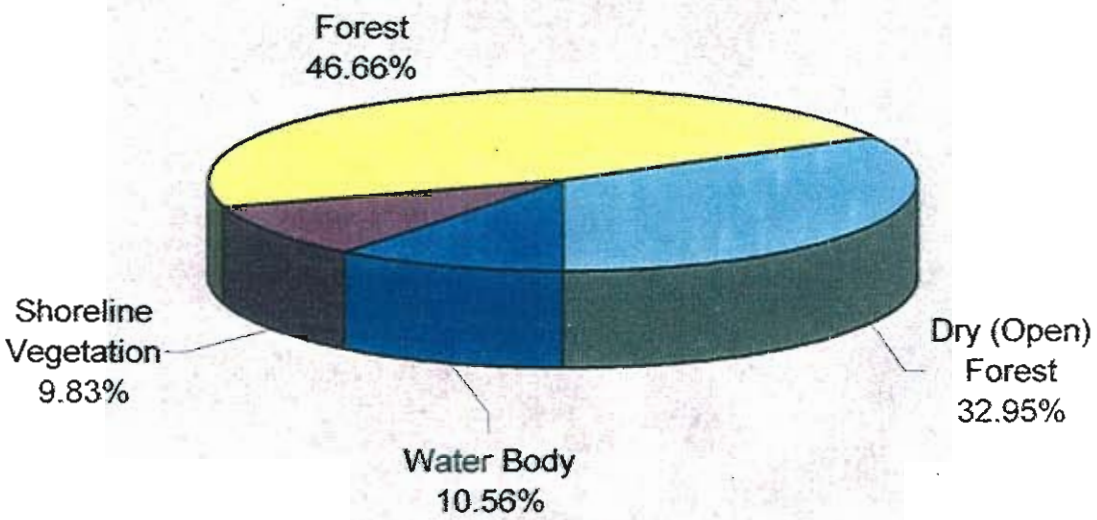
Scale 1:10000

Legend Title

- WATER BODIES
- SHORELINE VEGETATION
- FOREST
- DRY (OPEN) FOREST

ANNEX- 1.6(c)

Landuse Classification of Tulsi Lake Catchment Area



ANNEX- 1.7(a)

LAND USE AROUND VEHAR LAKE

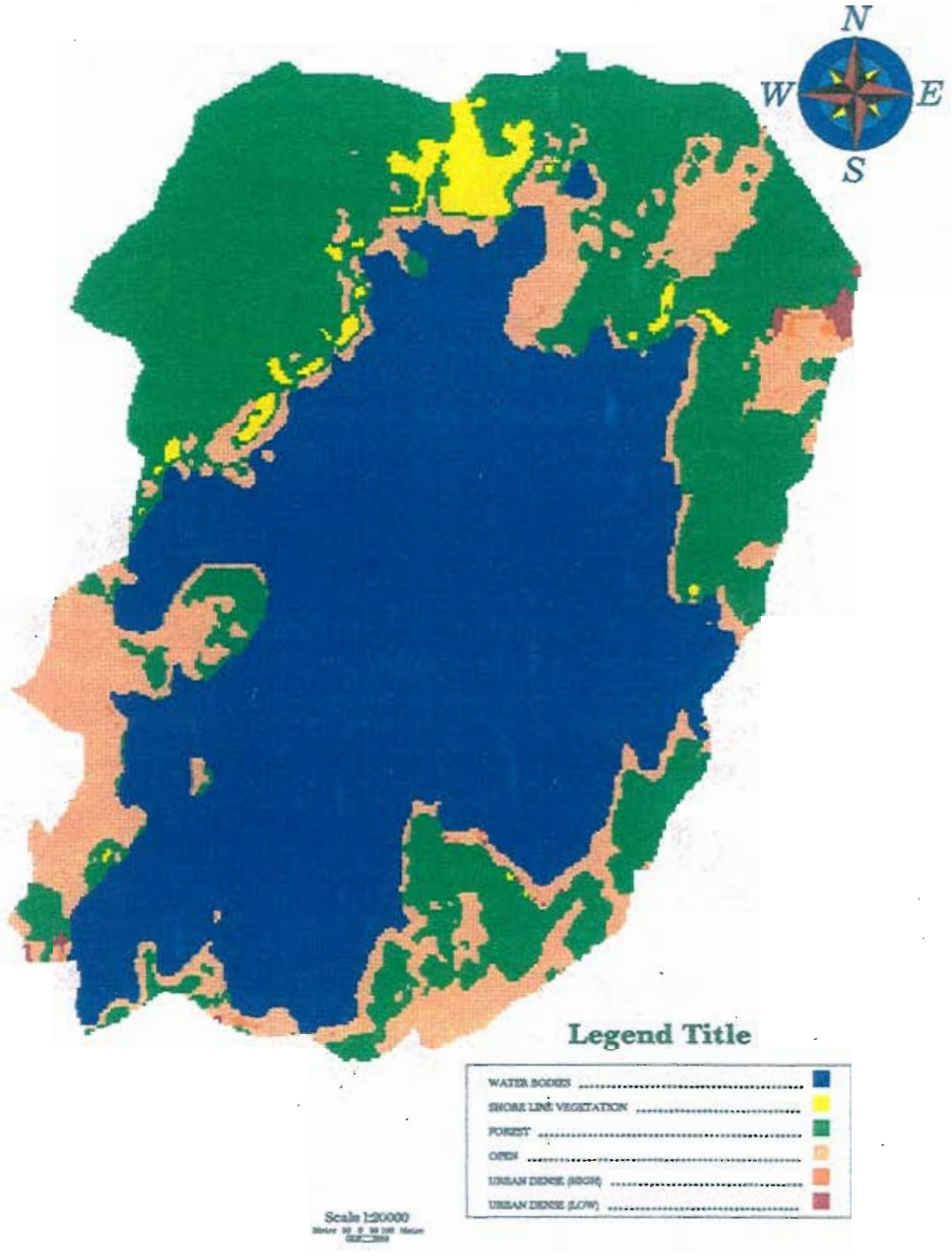
Legend Title

- WATER BODIES
- SHORE LINE VEGETATION
- FOREST
- OPEN
- URBAN DENSE (HIGH)
- URBAN DENSE (LOW)

Scale 1:20000

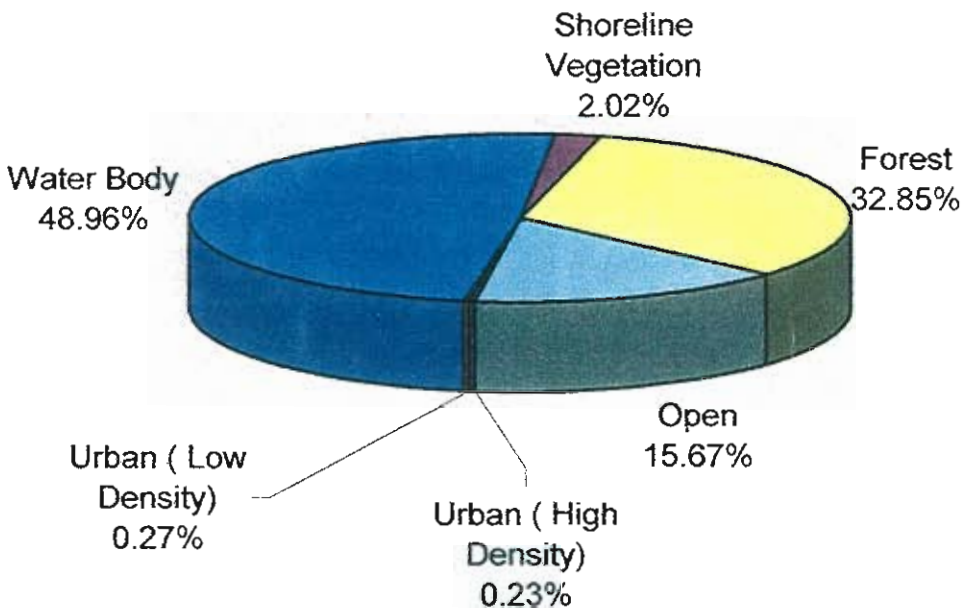
ANNEX- 1.7(b)

LAND USE MAP OF VEHAR LAKE CATCHMENT AREA



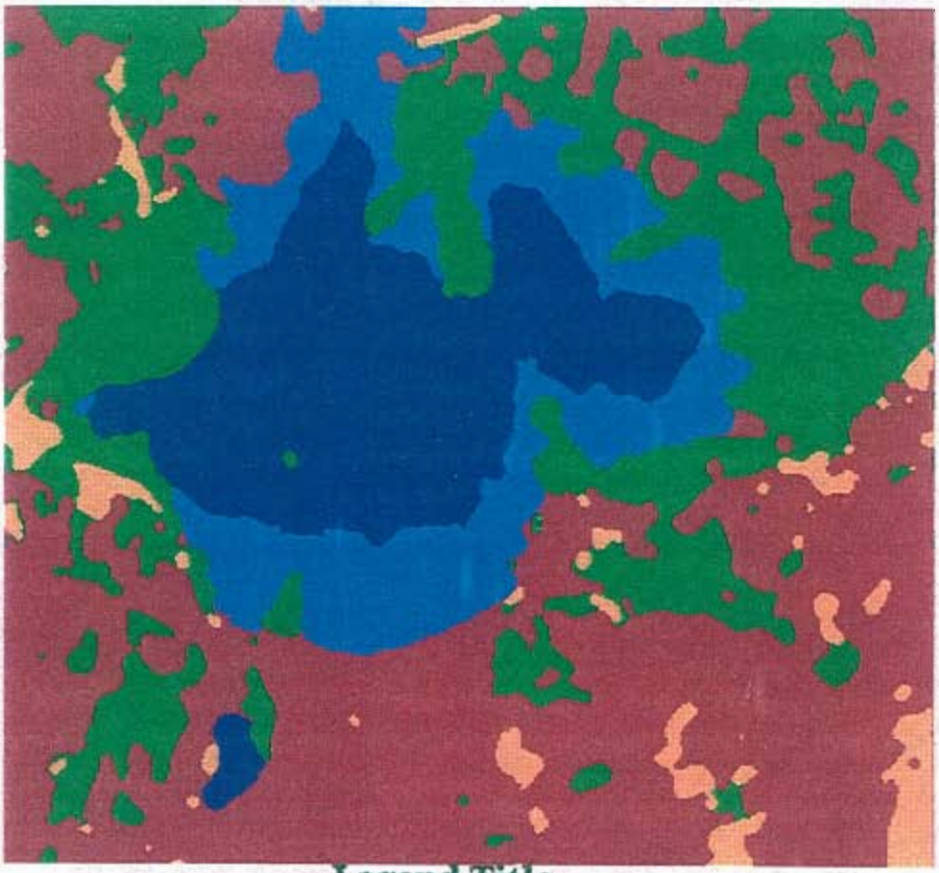
ANNEX- 1.7(c)

Landuse Classification of Vehar Lake Catchment Area



ANNEX-1.8(a)

LAND USE AROUND POWAI LAKE



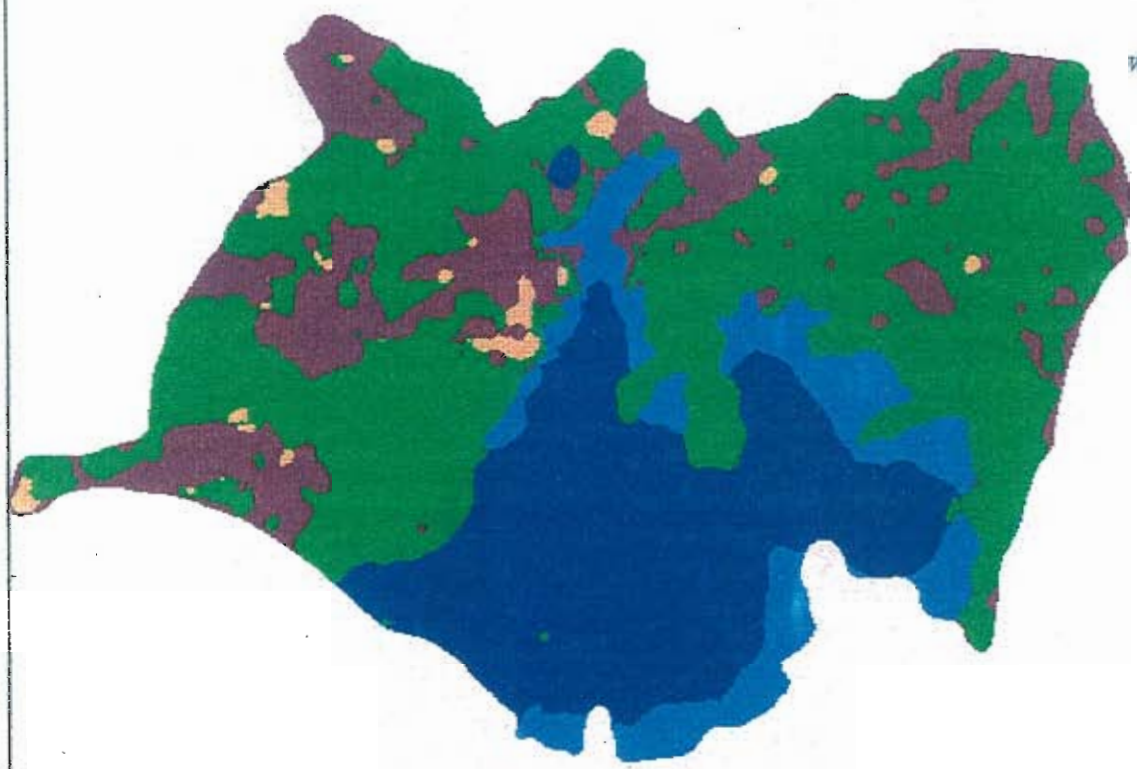
Legend Title

AQUATIC VEGETATION	
WATER BODY	
URBAN	
FOREST	
OPEN	

Scale 1:20000

Annex 1.8(b)

LAND USE MAP OF POWAI LAKE CATCHMENT AREA

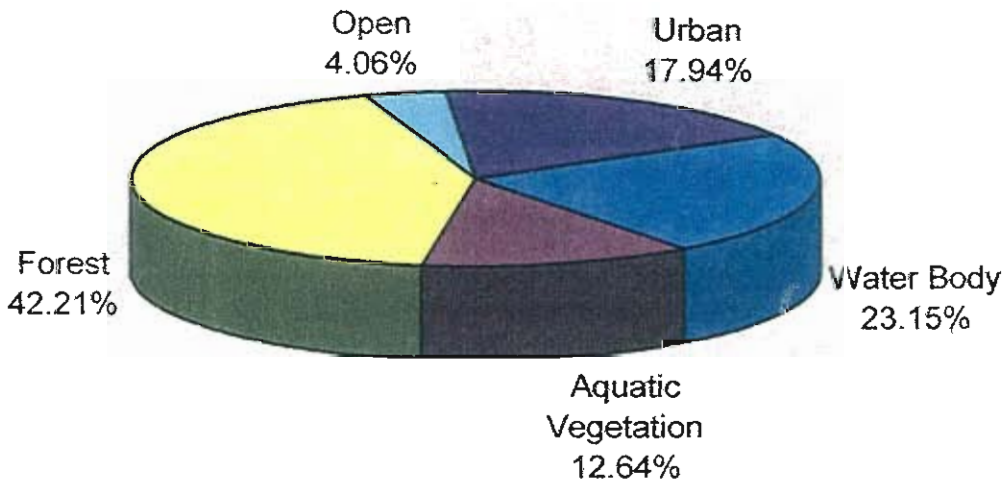


Legend Title

- AQUATIC VEGETATION
- WATER BODIES
- URBAN
- FOREST
- OPEN

Scale 1:20000

Landuse Classification of Powai Lake Catchment Area



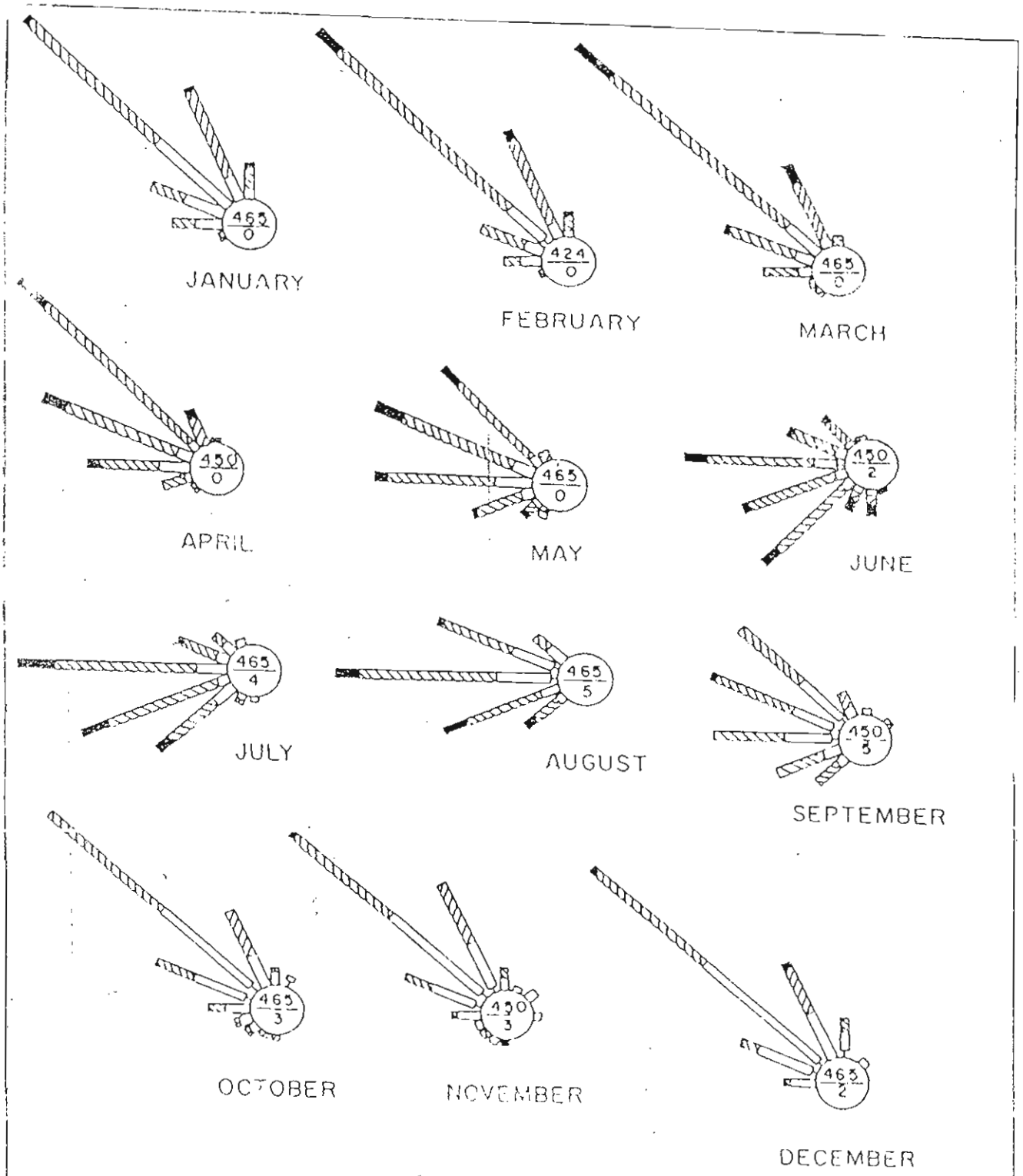
ANNEX 2.1 (A)

MONTHLY CLIMATOLOGICAL DATA FOR IMD SANTACRUZ OBSERVATORY (1995-1999)

Month	Temperature (^{0}C)		Humidity (%)		Atmospheric Pressure (Mb)		Rainfall (mm)
	Min	Max	Min	Max	Min	Max	
Jan	12.2	33.8	19.26	93.80	1006.78	1016.68	1.53
Feb	13.75	36.76	16.40	92.80	1006.40	1015.68	T.R.
Mar	17.36	39.18	12.80	91.80	1003.42	1014.18	T.R.
Apr	20.9	37.70	24.80	92.20	1002.04	1012.12	T.R.
May	24.02	33.56	42.80	89.20	1000.28	1011.26	41.4
June	23.86	35.28	53.00	94.25	995.70	1009.05	375.74
July	23.72	32.90	65.40	97.40	996.04	1006.36	636.14
Aug	24.10	31.94	64.20	96.80	998.50	1009.00	460.14
Sept	23.24	32.86	48.00	97.50	1000.26	1010.94	409.56
Oct	20.56	36.14	22.60	95.75	1001.06	1013.18	224.05
Nov	17.80	35.68	19.20	92.50	1005.06	1015.42	28.70
Dec	14.60	34.56	22.60	96.00	1006.80	1016.2	21.8

T.R. – Trace Rainfall (Rainfall <0.1mm)

Annex 2.1 (B)
WINDROSE DIAGRAM

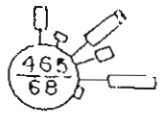


PERIOD : 1976 – 90

N : TOTAL NUMBER OF OBSERVATIONS.
C : TOTAL NUMBER OF CALMS IN PERCENTAGE FREQUENCIES

Annex 2.1 (C)

WINDROSE DIAGRAM



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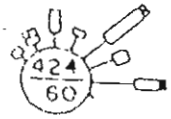

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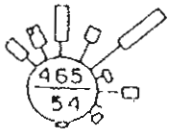

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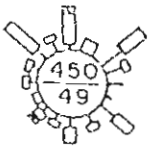

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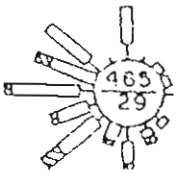

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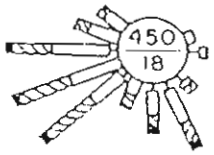

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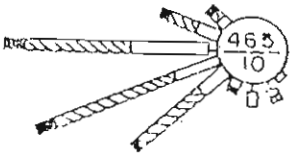

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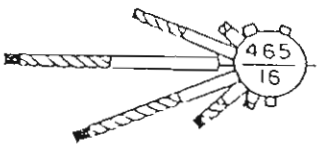

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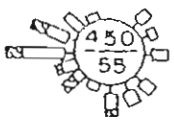

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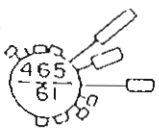

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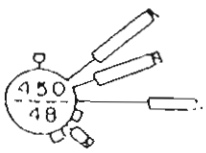
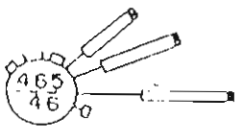


NOVEMBER



DECEMBER

SCALE OF FREQUENCIES

0 10 20 30 40 50 %

SCALE OF SPEEDS

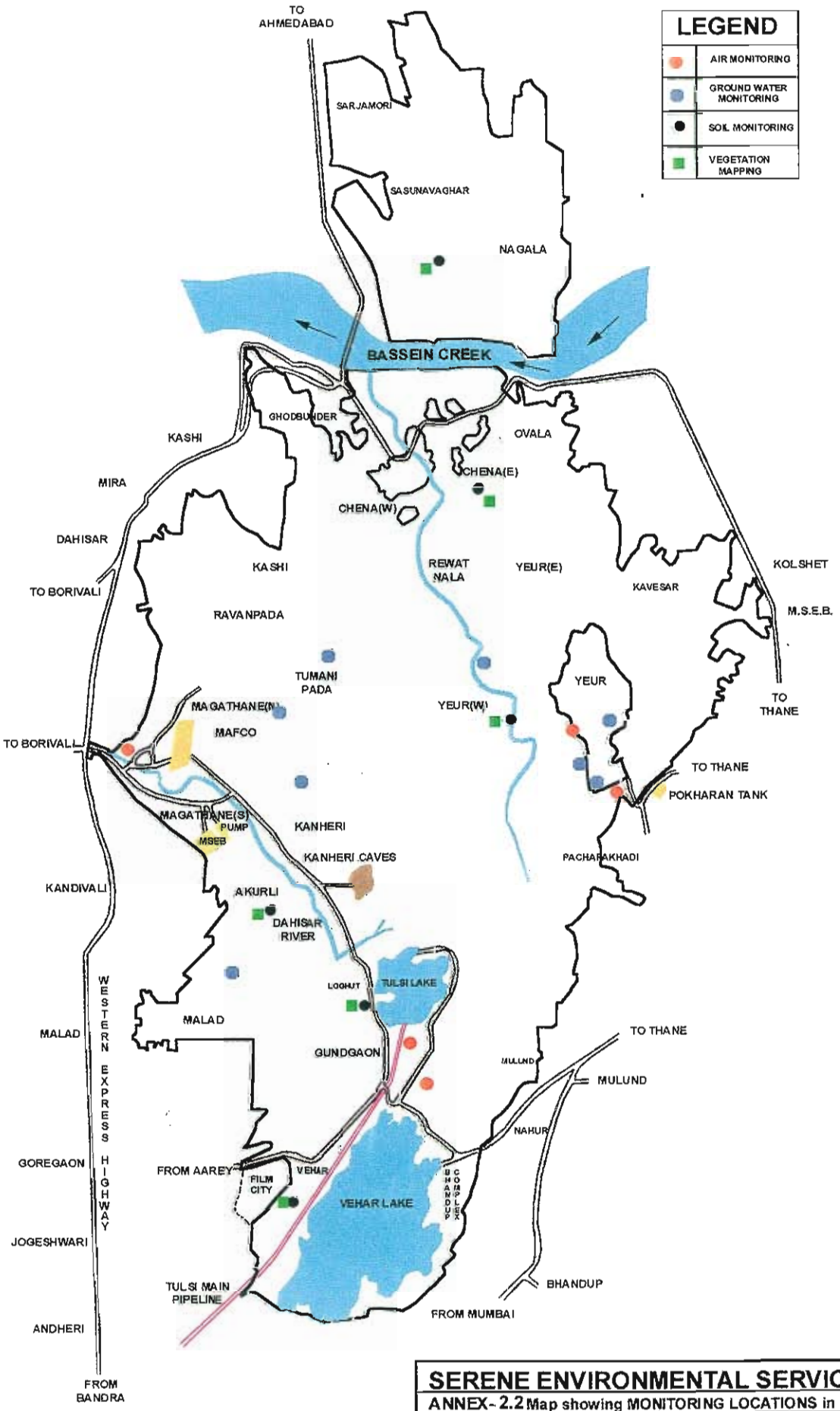
N / C 1-5 6-11 12-19 > 19 Kmph.

1-3 4-6 7-10 > 10 KNOTS

PERIOD : 1976 – 90

N : TOTAL NUMBER OF OBSERVATIONS

C : TOTAL NUMBER OF CALMS IN PERCENTAGE FREQUENCIES



SERENE ENVIRONMENTAL SERVICES

ANNEX- 2.2 Map showing MONITORING LOCATIONS in SGNP

CLIENT: MMR ENVIRONMENT IMPROVEMENT SOCIETY

ANNEX 2.3(A) AMBIENT AIR QUALITY AT SGNP FOR THE WHOLE YEAR

Monitoring Locations	SPM ($\mu g/m^3$)			RPM ($\mu g/m^3$)			SO_2 ($\mu g/m^3$)			NOx ($\mu g/m^3$)		
	Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
Yeur Gate	65	128	94.82	35	71.2	47.31	<6	12.3	7	18.3	25.9	22.3
Yeur Village	65.4	217.5	118.5	29.5	105.5	57.65	<6	12.3	5	17.84	29.66	22.56
Tulsi Lake	69.1	128	97.18	21.08	61	37.7	<6	12.2	4	12.7	37.2	24.31
Bhandup Complex	80.2	137	114.56	33.19	68.1	45	<6	10.4	6.05	16.7	28.4	22.5
Borivali Gate	46.4	299.7	162	32.32	72.8	54	<6	14.2	7.3	11.67	34.2	23.41
Kandivali	70.4	163.7	84.27	37.7	67.4	52.89	<6	12.7	7	13.9	34.9	23.54
NAAQS – Sensitive area (24 hrs)	100			75			30			30		

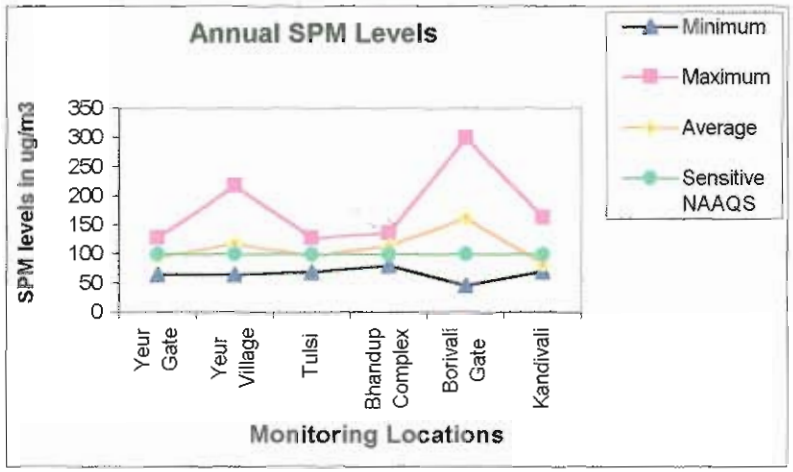
(B) AMBIENT HC & CO LEVELS

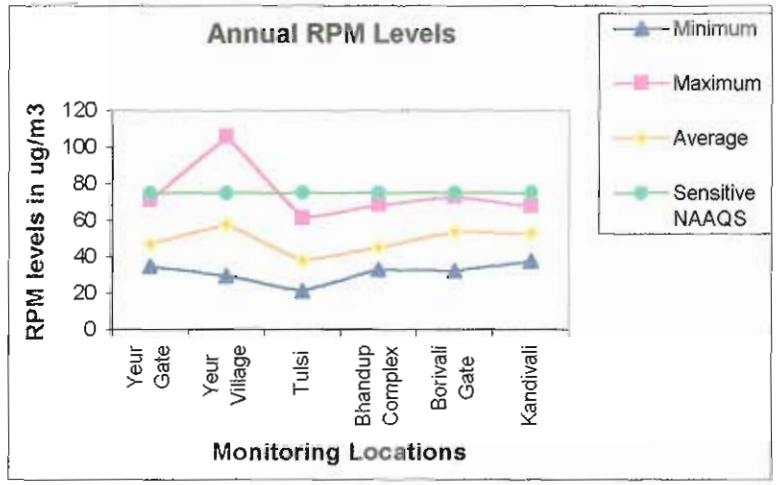
Monitoring Locations	Carbon Monoxide ($\mu g/m^3$)			Hydrocarbons ($\mu g/m^3$)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Yeur Gate	0.33	0.36	0.36	0.012	0.015	0.014
Yeur Village	0.25	0.35	0.31	0.011	0.025	0.019
Tulsi Lake	0.24	0.33	0.28	0.009	0.019	0.013
Bhandup Complex	0.25	0.38	0.31	0.023	0.034	0.028
Borivali Gate	0.38	0.58	0.47	0.031	0.036	0.033
Kandivali	0.58	0.6	0.56	0.039	0.04	0.038
NAAQS Sensitive area – 1hour	2000			--		

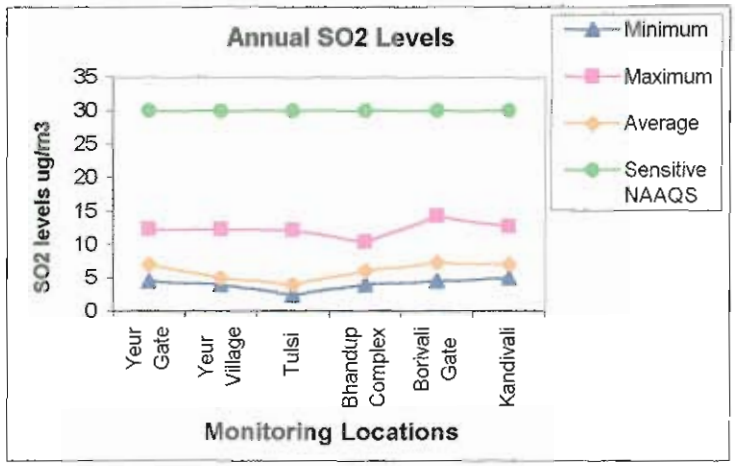
(C) NATIONAL AMBIENT AIR QUALITY STANDARDS

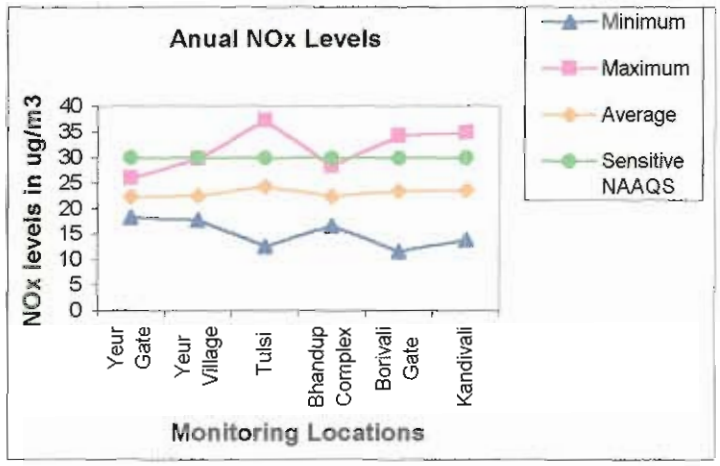
Sr. No.	Pollutant	Averaging Time	Concentration in Ambient Air (µg/m3)		
			Industrial	Residential	Sensitive
1	SO_2	Annual 24 hrs	80 120	60 80	15 30
2	NO_X	Annual 24 hrs	80 120	60 80	15 30
3	Suspended Particulate Matter	Annual 24 hrs	360 500	140 200	70 100
4	Respirable Particulate Matter (size < 10 µm)	Annual 24 hrs	120 150	60 100	50 75
5	Carbon Monoxide	8 hrs 01 hr	5000 10000	2000 4000	1000 2000

Annex 2.4 Annual Average Air Pollutant Levels in SGNP

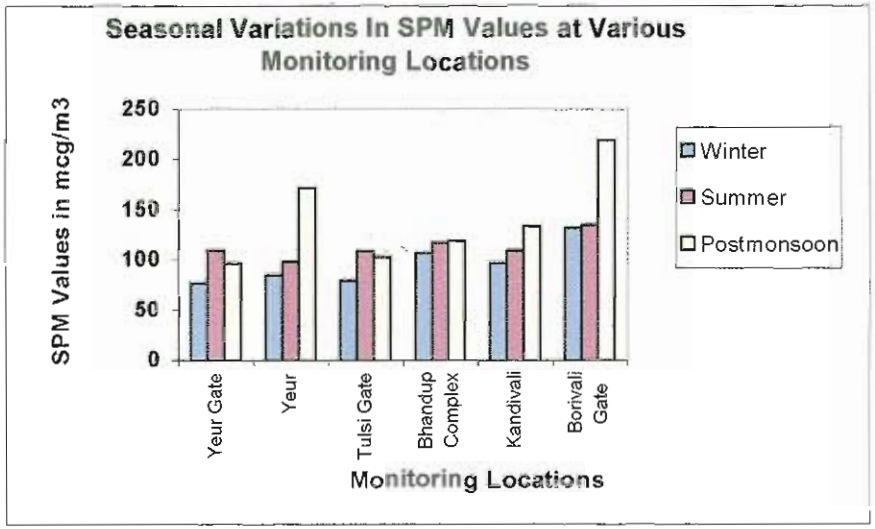


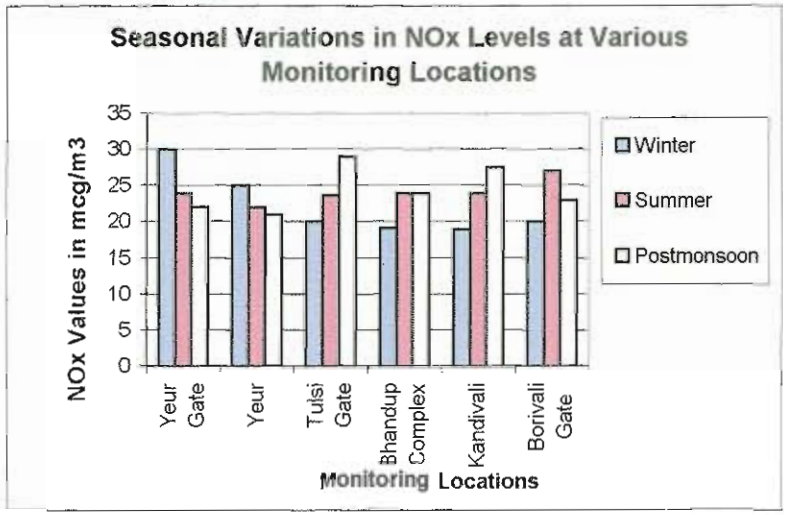


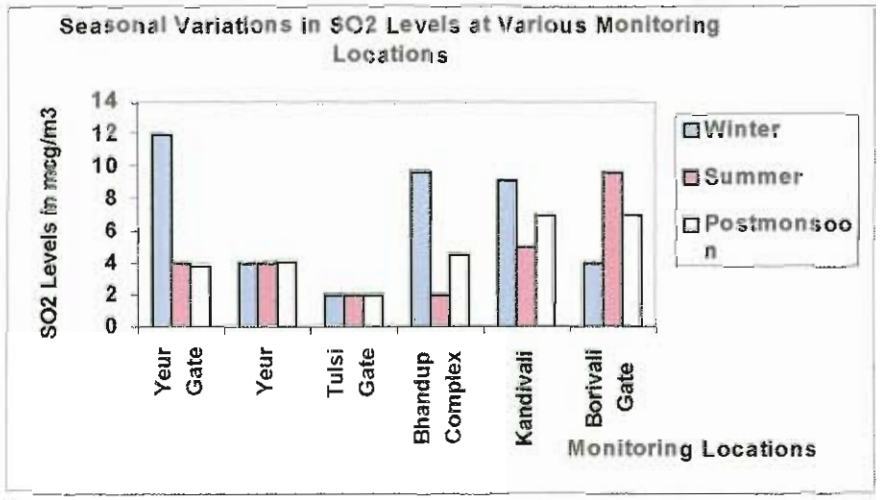


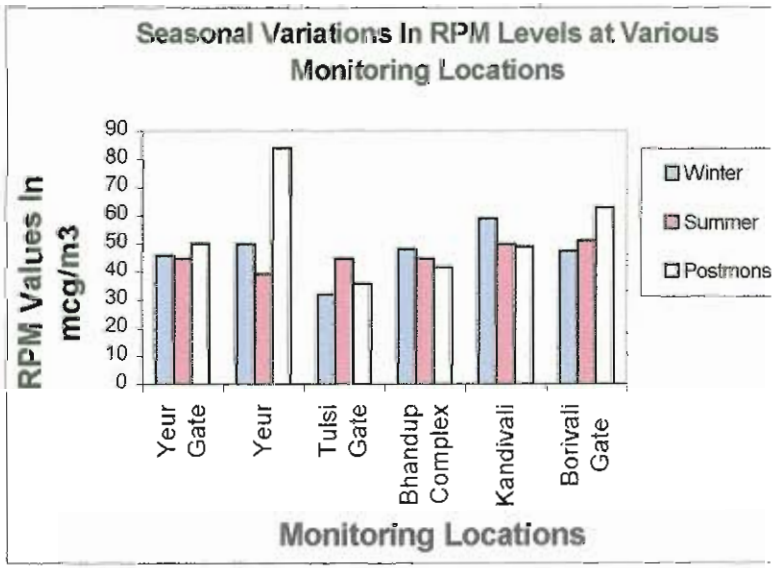


ANNEX 2.5 SEASONAL VARIATIONS IN AIR QUALITY









ANNEX 2.6 (A) SEASONAL BASELINE NOISE LEVEL DATA IN STUDY AREA

Location	Season	Noise Levels dB(A)		
		Day Time	Night Time	Average
Tulsi Lake	Winter	35 – 39	30 – 36	36
	Summer	39 – 47.3	38 – 39.5	43
	Post monsoon	41 – 56	39 - 47	47
Yeur Village	Winter	33 – 56	34 – 47	41
	Summer	39 – 58	38 – 41	44
	Post monsoon	40 – 58	39 - 50	50
SGNP Entrance	Winter	35 – 61	35 – 46	47
	Summer	39.5 – 65.3	37 – 49.5	51
	Post monsoon	40 – 60	38 - 53	49

(B) The CPCB Noise Standards

AREA CODE	CATEGORY OF AREA	LIMITS IN d B (A)	
		DAY TIME	NIGHT TIME
(A)	Industrial area	75	70
(B)	Commercial area	65	55
©	Residential area	55	45
(D)	Silence zone	50	40

NOTE :

1. *Day time is reckoned between 6 a.m. to 10 p.m.*
3. *Night time is reckoned between 10 p.m. to 6 a.m.*
3. *Silence zone is defined as area upto 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the Competent Authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.*

Mixed categories of areas should be declared as one of the four above mentioned categories by the competent Authority and the corresponding standards shall apply.

Annex 2.7 (A) GROUND WATER ANALYSIS SUMMARY

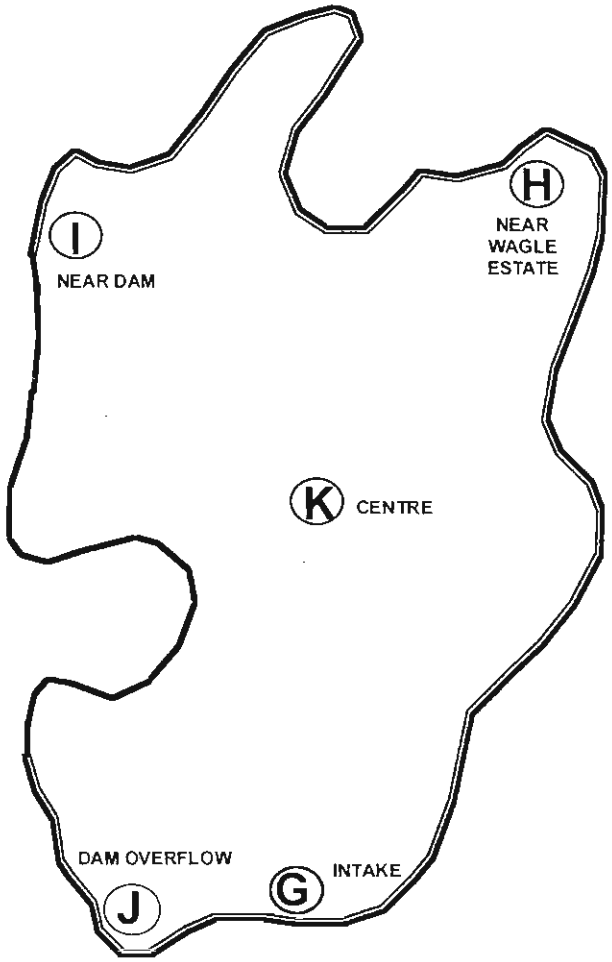
Location	pH	Turbidity	EC	TDS	D.O.	Hardness	Alkalinity	Nitrate	Chloride	Sulphate	Iron	Lead	Manganese	Pesticide	MPN/100ml	E.coli/100ml
Mafco Bore well	7.4 - 7.83	<5	698 -1050	494 -616	5.4- 6.2	232 -248	154 -262	0.022 -1.2	98	3.57 -135	0.05 -1.5	< 0.04	<0.3 - .95	0.001	6 -350	Absent
Bambuhut	6.3- 7.44	<5	238 - 620	154 - 181	6.2 - 7.8	90 - 258	8 - 224	0.9- 0.98	21	12-Jan	.02 -4.7	< 0.04	<0.3 - 1.8	< 0.001	Nil - 120	Absent
Tumnipada	6.2 - 7.5	<5	240 - 324	172 - 182	7.0 - 7.02	76 - 140	70 - 100	0.9 - 1.5	24	1.9 - 13	0.02 - 2.8	< 0.04	<0.3 - 1.2	< 0.001	8 - 1600	Absent
Gautam nagar	6.41- 7.32	ND	269 - 300	196	6.8 - 7.2	100 - 114	64 - 69	0.001 - 0.98	30	2.1 - 17	0.01 - 0.15	< 0.04	0.06- 3 0.7	0.008	350 - 1800	Nil - 12
Yeur Bore well	7.5 - 7.8	ND	350 - 675	348	4 - 7.8	216 - 244	123 - 222	0.06 - 0.98	47	1.9 - 28	0.022 - 0.2	< 0.04	0.064 - 0.7	< 0.001	Nil - 8	Absent
Bhendi Stream	7.3 - 7.4	1	175 - 269	323	7.2 - 7.3	58 - 162	44 - 68	0.9 - 0.012	22	21-Jan	0.011 - 0.3	< 0.04	0.004 - 0.01	0.01	Nil - 13	Absent
Yeur Open well	7.5	ND	563	ND	6.6	244	140	0.04	ND	7.14	0.03	< 0.04	0.058	0.005	25	Absent
IS 10500: 1991	6.5 - 8.5	5		500		300	200	45	250	200	0.3	0.05	0.1		10	Not specified
	ND - Test Not Done															
	Units : all parameters are expressed in mg/l except pH, Turbidity. Turbidity is expressed in NTU															

Annex 2.7 (B) Surface Water Quality Analysis Results

Sr. No.	Parameters	Ganeshsagar Lake	Khadan Lake	Chenna in Core Forest	Chenna River Outlet	Dahisar Inlet	Dahisar Outlet
1.	Colour	Colourless	Colourless	Colourless	Colourless	Colourless	Colourless
2.	Odour	Odourless	Odourless	Odourless	Odourless	Odourless	Odourless
3.	pH	7.85	7.4	7.3	7.3	7.06	7.3
4.	Electrical Conductivity (µs/cm)	378	174.9	175	16640	205.0	350.0
5.	Turbidity (NTU)	<5.0	<5.0	1.0	11.4	7.3	13.7
6.	Dissolved Oxygen	-	-	7.3	4.0	8.3	8.0
7.	Total dissolved solids (mg/l)	285	157	323	12064	130.0	219.0
8.	Total Hardness(as $CaCO_3$) mg/l	178	54	58	1940	74.0	134.0
9.	Total Alkalinity	98	50	44.0	110.	60.0	106.0
10.	Sulphates(as SO4)	15.0	5.0	22.0	ND	10.0	28.0
11.	Nitrates	ND	ND	ND	ND	ND	ND
12.	Chlorides (as Cl)	32	17	22	6270	22.0	32.0
13.	Phosphates	0.45	ND	ND	0.15	ND	0.092
14.	Lead (as Pb) mg/l	ND	ND	ND	ND	ND	ND
15.	Iron (as Fe) mg/l	0.2	0.15	0.3	0.5	0.3	0.5
16.	Manganese (as Mn) mg/l)	0.01	0.01	0.01	0.05	ND	0.1
17.	MPN/ 100ml	1800+	1800+	Nil	11.0	350	1800+
18.	E.coli / *100ml*	Absent	Absent	Absent	Absent	Absent	Absent

Annex 2.7 (C) Creek water analysis results

Sr. No.	Parameters	Results
1	Colour	Highly Turbid
2	Odour	Odourless
4	PH	7.8
6	Turbidity (NTU)	673.0
7	Dissolved Oxygen	3.3
8	Total suspended solids (mg/l)	8160.0
10	BOD (mg/l)	< 10.0
11	Oil and Grease (mg/l)	6.2
12	Iron (as Fe) mg/l	18.25
13	Manganese (as Mn) mg/l	N.D.
14	Lead (as Pb) mg/l	< 0.1
15	MPN/ 100ml	17



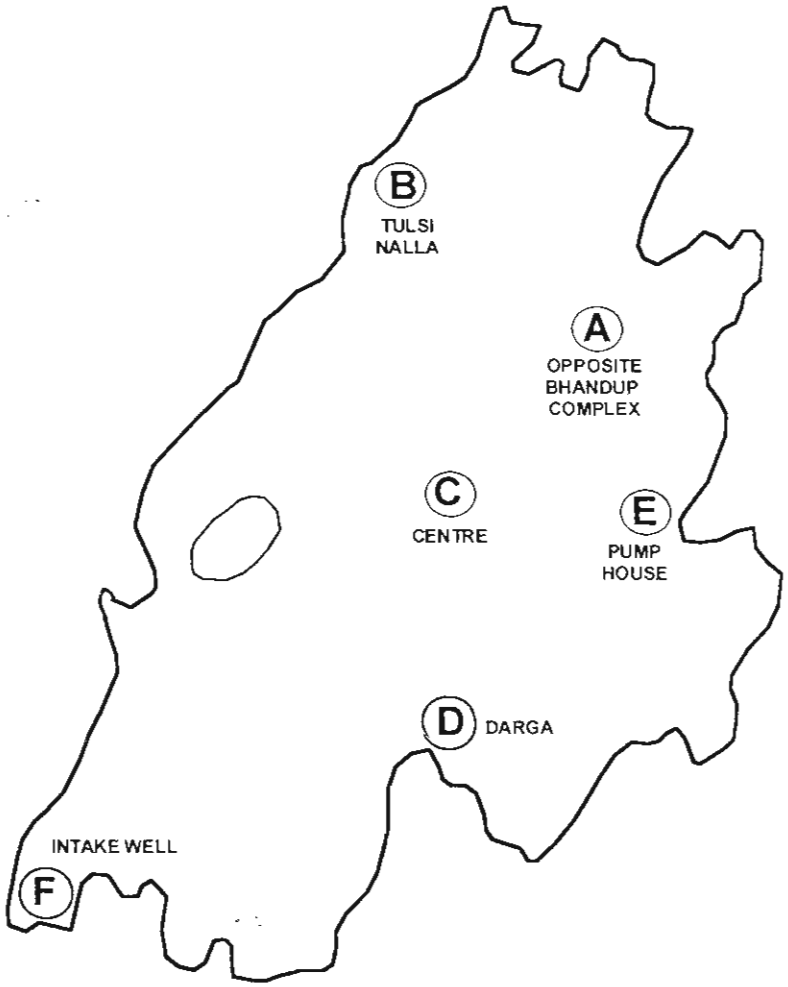
LEGEND

G, H, I, J, K	WATER SAMPLING, SECCHI DEPTHS, PLANKTON
G, H, I, J	SEDIMENT SAMPLING
K	DO & TEMPERATURE PROFILE

SERENE ENVIRONMENTAL SERVICES

ANNEX-2.8(a)TULSI LAKE MONITORING LOCATIONS

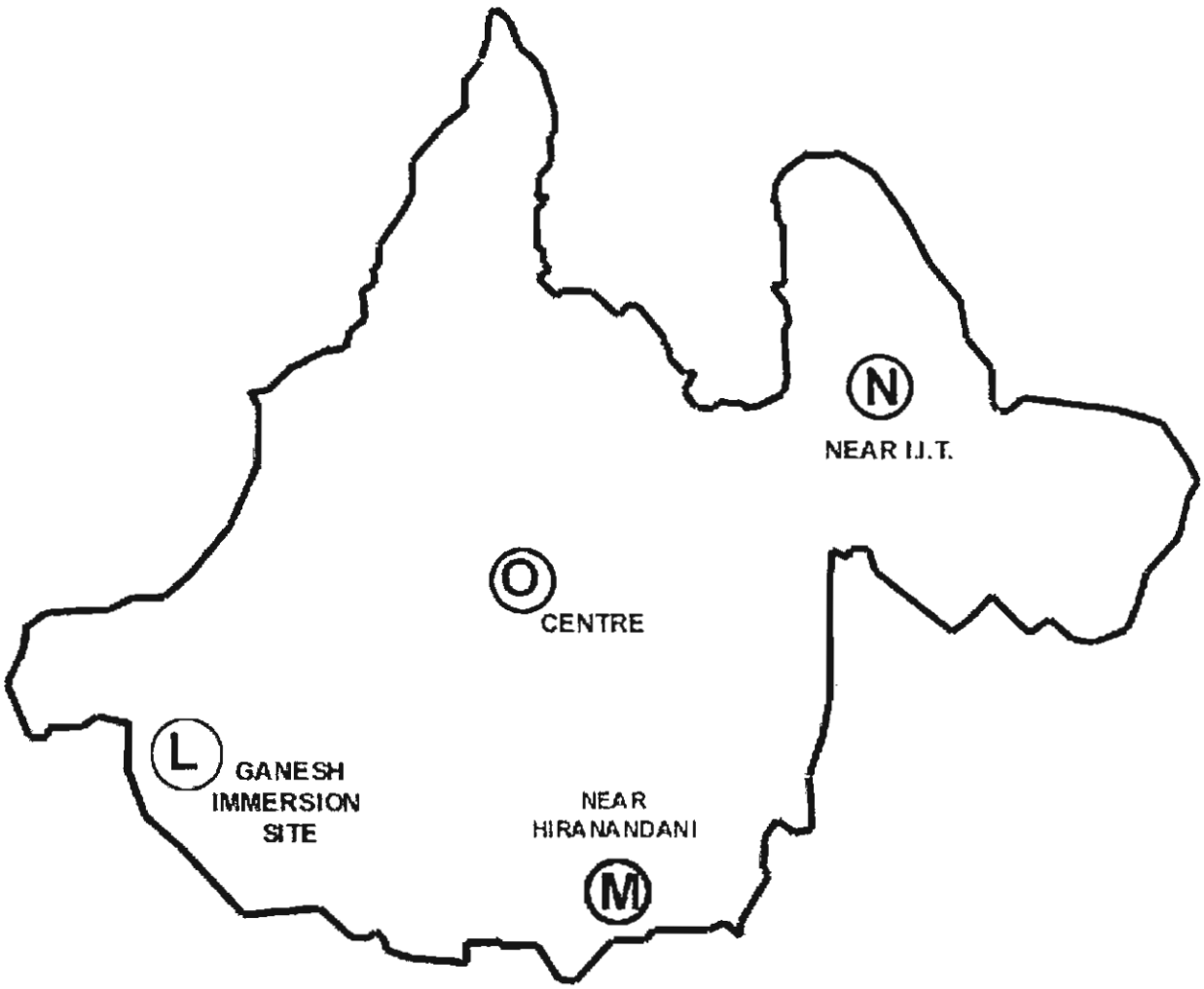
CLIENT: MMR ENVIRONMENT IMPROVEMENT SOCIETY



LEGEND	
A, B, C, D, E, F	WATER SAMPLING, SECCHI DEPTHS, PLANKTON
B, D, E, F	SEDIMENT SAMPLING
C	DO & TEMPERATURE PROFILE

SERENE ENVIRONMENTAL SERVICES
ANNEX-2.8(b) VEHAR LAKE MONITORING LOCATIONS
CLIENT: MMR ENVIRONMENT IMPROVEMENT SOCIETY

LEGEND	
L,M,N,O	WATER SAMPLING, SECCHI DEPTHS, PLANKTON
O	DO & TEMPERATUE PROFILE, SEDIMENT SAMPLING



SERENE ENVIRONMENTAL SERVICES
ANNEX–2.8(c) POWAI LAKE MONITORING LOCATIONS
CLIENT: MMR ENVIRONMENT IMPROVEMENT SOCIETY

Annex 2.9 (A) Tulsi Lake Water Analysis Summary

Location		pH	Turbidity	EC	TDS	Hardness	Alkalinity	Phosphorus	Nitrogen	Chloride	Sulphate	Iron	Zinc	Manganese	BOD	COD	Pesticide	Chlorophyll a	MPN	E.coli	Secchi Disc
G	Min	7.42	4.3	119	75	45	40	<0.05	0.28	10	2.1	0.05	0.17	0.09	4	<10		0.24	Nil	Nil	100
	Max	8.36	13	361	235	88	80	0.09	8.4	22	6	1.3	<1.0	0.26	5	21		0.7	Nil	Nil	124
	Avg	8.04	7.7	207	140	71	65	0.08	3	18	4.4	0.51	0.09	0.12	4	14	0.014	0.45	Nil	Nil	110
H	Min	7.47	5.1	120	74	45	36	<0.05	0.14	12	1.6	0.05	<0.005	< 0.3	3	10		0.238	Nil	Nil	100
	Max	8.3	10	341	203	72	74	0.09	4.76	21	5	1.3	0.17	0.26	7	21.6		0.7	2	Nil	124
	Avg	7.83	8.06	203	128	63	61	0.07	1.78	17.76	3.2	51	0.09	0.12	5	14	0.042	0.45	1	Nil	112
I	Min	7.31	7.31	119	74	50	38	0.056	0.14	9	1.4	0.05	<0.005	0.09	4	13		0.19	Nil	Nil	95
	Max	7.97	18	300	195	76	75	0.92	4.2	19.88	4	1.3	0.9	0.16	6	17		0.56	Nil	Nil	125
	Avg	7.91	11.4	190	114	72	58	0.35	1.61	15.96	2.8	0.51	0.09	0.1	5	10	0.014	0.34	Nil	Nil	113
J	Min	7.56	6.7	120	73	44	38	0.042	0.14	10	1.3	0.1	<0.005	< 0.3	5	10		0.218	Nil	Nil	100
	Max	8.5	16	361	203	82	83	0.9	2.8	22.72	7	1.2	0.9	0.26	6	14.4		0.58	20	4	130
	Avg	7.69	10.46	211	130	68	62	0.35	1.13	18.24	4.4	0.48	0.36	0.12	5	11.8	0.012	0.426	8	2	115
K	Min	7.03	5.4	119	75	44	40	0.056	0.28	8	3	0.05	<0.1	< 0.3	<5	10		0.235	Nil	Nil	90
	Max	8.47	15	323	210	72	72	1.84	4.2	25.56	10.71	1.8	<1	0.09	10	25		0.76	25	4	125
	Avg	7.69	9.7	200	130	62	61	0.66	1.68	17.8	5.57	0.68	<1.0	0.06	7	18	0.014	0.495	10	2	109

G - Intake Well
H - Near Wagle Estate
I - Dam
J - Dam Overflow
K - Lake Centre
Refer Annex 2.8(A) for monitoring locations.

Note - Min :- Minimum value recorded in all 3 seasons
Max :- Maximum value recorded in all 3 seasons
Avg. :- Average value of all 3 seasons
ND - Test Not Done
Units : all parameters are expressed in mg/l except pH, Turbidity. Turbidity is expressed in NTU

Annex 2.9 (B) Vihar Lake Water Analysis Summary

Location		pH	Turbidity	EC	TDS	Hardness	Alkalinity	Phosphorus	Nitrogen	Chloride	Sulphate	Iron	Zinc	Manganese	BOD	COD	Pesticide	Chlorophyll a	MPN	E.coli	Secchi Disc
A	Min	7.51	3.6	126	76	54	42	0.014	0.47	8	2.5	0.05	0.053	<0.3	<5	<10		0.24	9	Nil	82
	Max	7.94	7.7	307	200	162	74	0.37	12.8	26	5	1.2	<1.0	0.145	6	18		0.7	20	4	140
	Avg	7.73	5.03	193	134	92.6	58	0.158	5.26	17.96	3.69	0.46	0.351	0.11	4	14	0.01	0.49	13	2	105
B	Min	7.51	3	120	80	48	40	0.06	0.4	11	3.57	0.05	0.15	<0.3	<5	<10		0.095	Nil	Nil	66
	Max	8	11.1	423	275	208	72	0.46	1.44	23	4	1.3	<.1	1.86	7	25.2		0.48	50	4	150
	Avg	7.81	5.9	228	157	105	56	0.292	0.74	17.48	3.85	0.55	0.38	0.6	5	18	0.037	0.49	35	2	104
C	Min	7.68	7.31	119	74	50	38	0.056	0.14	9	1.4	0.05	<0.005	<0.3	4	13		0.19	Nil	Nil	73
	Max	7.87	18	300	195	76	75	0.92	4.2	19.88	4	1.3	0.9	0.11	6	17		0.56	Nil	Nil	150
	Avg	7.76	4.66	201	133	79	53	0.185	1.2	16.82	3.2	0.56	0.36	0.7	5	10	0.014	0.34	Nil	Nil	105
D	Min	7.56	6.7	120	73	44	38	0.042	0.14	10	1.3	0.1	<0.005	<0.3	5	10		0.218	Nil	Nil	75
	Max	8.5	16	361	203	82	83	0.9	2.8	22.72	7	1.2	0.9	0.26	6	14.4		0.58	20	4	145
	Avg	7.69	10.46	211	130	68	62	0.35	1.13	18.24	4.4	0.48	0.36	0.12	5	11.8	0.012	0.426	8	2	104
E	Min	7.03	5.4	119	75	44	40	0.056	0.28	8	3	0.05	<.1	<0.3	<5	10		0.235	Nil	Nil	87
	Max	8.47	15	323	210	72	72	1.84	4.2	25.56	10.71	1.8	<1	0.72	10	25		0.76	25	4	150
	Avg	7.69	9.7	200	130	62	61	0.66	1.68	17.8	5.57	0.68		0.4	7	18	0.014	0.495	10	2	111
F	Min	7.72	3.2	126	90	53	40	0.028	0.28	10	1.3		0.037	<0.3	<5	<10		0.238	2	Nil	75
	Max	8.18	6.6	346	225	152	74	0.09	4.2	28	9	1.6	0.93	0.21	8	25.2		0.54	175	7	160
	Avg	7.99	4.6	206	149	89	56	0.059	1.58	21.18	5.1	0.85	1.467	0.12	6.6	18.4	0.014	0.38	61	2	106

Note - Min :- Minimum value recorded in all 3 seasons
Max :- Maximum value recorded in all 3 seasons
Avg. :- Average value of all 3 seasons

Locations - A - Opposite Bhandup Complex
B - Tulsi Nallah
C - Lake Centre
D - Darga
E - Pump House
Refer Annex 2.8(B) for monitoring locations.

ND - Test Not Done

Units : all parameters are expressed in mg/l except pH, Turbidity. Turbidity is expressed in NTU

Annex 2.9 (C) Powai Lake Water Analysis Summary

Location		pH	Turbidity	EC	TDS	Hardness	Alkalinity	Phosphorus	Nitrogen	Chloride	Sulphate	Iron	Zinc	Manganese	BOD	COD	Pesticide	Chlorophyll	MPN	E.coli	Secchi Disc
L	Min	7.11	8.7	336	212	130	120	<0.05	0.75	23	10.71	<0.05	0.05	<0.3	4	<10		0.29	8	Nil	30
	Max	8	52.7	501	305	184	194	0.84	2.58	65	17	1.8	<.5	0.6	15	32		1.664	275	20	35
	Avg	7.65	29.8	435	274	161	167	0.392	1.44	44	13.4	1.1	0.135	0.3	8	20.2	0.068	1.02	102	10	32.5
M	Min	7.22	9.7	340	230	130	124	ND	0.65	23	7.14	0.2	0.03	<0.3	<5	<10		0.28	8	Nil	29
	Max	8.05	52.1	529	344	182	180	0.66	2.03	48	15	1.7	0.08	0.4	12	30		1.98	175	12	45
	Avg	7.7	32.26	456	280	158	167	0.574	1.23	38.34	11.54	0.73	0.14	0.22	8	30	0.012	1.08	78	6	37
N	Min	7.24	35	480	264	160	171	0.35	0.74	48	10.71	0.28	0.17	0.15	12	29		0.54	80	Nil	30
	Max	8.25	49.7	499	312	184	192	0.54	1.66	51	15	1.9	<.5	0.35	18	44.8		1.542	275	7	40
	Avg	7.75	42.35	490	288	173	182	0.45	1.2	50	12.9	1.23	0.235	0.25	15	37	0.07	1.04	178	5	35
O	Min	7.26	25	390	245	160	46	0.336	0.56	39	3.57	0.25	0.11	0.15	9	20.4		0.58	275	Nil	33
	Max	7.6	245	484	254	184	171	0.54	1.66	49	10	2	<.5	0.39	10	27		0.758	250	Nil	40
	Avg	7.43	135	437	250	172	108	0.438	1.11	44.35	7	1.13	0.205	0.27	9.5	24	0.014	0.664	262	Nil	36

Note - Min :- Minimum value recorded in all 3 seasons
Max :- Maximum value recorded in all 3 seasons
Avg. :- Average value of all 3 seasons

ND - Test Not Done

Units : all parameters are expressed in mg/l except pH, Turbidity. Turbidity is expressed in NTU

L - Ganesh Immersion Site
M - Near Hiranandani Complex
N - Near I.I.T.
O - At the Centre

Refer Annex 2.8(C) for monitoring locations.

Annex 2.10 DRINKING WATER STANDARDS – IS 10500:1991

SR.NO.	PARAMETERS	Limits as per IS10500:1991 (max)
1.	Colour	5.0
2.	Odour	Unobjectionable
3.	Taste	Agreeable
4.	Turbidity (NTU)	5
5.	PH	6.5 to 8.5
6.	TDS	500
7.	Total Hardness as a CaCO3	300
8.	Iron as Fe	0.3
9.	Chlorides as Cl	250
10.	Residual free Chlorine	Min 0.2
11.	Calcium as Ca	75
12.	Copper as Cu	0.05
13.	Manganese as Mn	0.1
14.	Sulphate as SO4	200
15.	Nitrates as NO3	45
16.	Fluorides as F	1.0
17.	Phenolic Compounds as C6H5OH	0.001
18.	Mercury as Hg	0.001
19.	Cadmium as Cd	0.01
20.	Selenium as Se	0.01
21.	Arsenic as As	0.05
22.	Cyanide as CN	0.05
23.	Lead as Pb	0.05
24.	Zinc as Zn	5.0
25.	Anionic detergents	0.2
26.	Chromium as Cr+6	0.05
27.	Mineral oil	0.01
28.	Pesticides	Absent
29.	Alkalinity as aCaCO3	200
30.	Aluminium as Al	0.03
31.	Magnesium as Mg	30.0
32.	Boron as B	1.0
33.	Polynuclear Aromatic Hydrocarbons (gm/lit)	-
34.	Total Plate Count (org/ml)	100
35.	Coliforms/100ml	10
36.	Faecal coliforms	Not Specified
37.	E.coli	Not Specified

ANNEX 2.11 Sediment Analysis Results

(A) Vihar Lake

Sr.No.	Parameters	Sample B	Sample D		Sample E		Sample F
		Winter	Winter	Post Monsoon	Winter	Post Monsoon	Winter
1.	Iron (as Fe)	0.3	0.21	11.61	0.031	11.61	0.29
2.	Manganese (as Mn)	0.08	0.02	0.31	0.02	0.22	0.07
3.	Zinc (as Zn)	0.02	0.03	3.31	0.01	2.73	0.41
4.	Organo-phosphorus pesticide	0.014	0.013	--	0.017		0.022
5.	Organo-chlorine pesticide	Traces	0.0001	--	Traces		Traces
6.	Lead	--	--	0.77	--	0.12	0.003
7.	Mercury	--	--	< 0.025	--	< 0.025	Traces
8.	Chromium	--	--	0.002	--	.0.0015	0.009

(B) Tulsi Lake

Sr.No.	Parameters	Sample H		Sample I		Sample J	Sample G
		Winter	Post monsoon	Winter	Post monsoon	Winter	Winter
1.	Iron (as Fe)	0.21	16.76	0.31	10.83	0.32	0.26
2.	Manganese (as Mn)	0.02	0.25	0.01	0.17	0.03	0.01
3.	Lead (as Pb)	0.003	0.062	--	0.047	--	0.004
4.	Mercury (as Hg)	Traces	< 0.025	--	< 0.025	--	0.0001
5.	Chromium (as Cr)	0.008	0.001	--	0.001	--	0.009
6.	Zinc (as Zn)	0.005	0.16	0.45	0.12	0.05	0.01
7.	Organo-phosphate pesticide	0.0132	--	0.022	--	0.022	0.008
8.	Organo-chlorine pesticide	0.0015		Traces		0.0001	0.0001

Note : All results are in mg/kg.

(C) Powai Lake

Sr.No.	Parameters	Center of the Lake	
		Winter	Post monsoon
1.	Iron (as Fe)	1.8	8.89
2.	Manganese (as Mn)	0.55	0.11
3.	Zinc (as Zn)	0.61	8.42
4.	Lead (as Pb)	0.025	10.94
5.	Chromium (as Cr)	0.045	0.0033
6.	Mercury (as Hg)	Traces	<0.025
7.	Organo-phosphorus pesticide	0.07	--
8.	Organo-chlorine pesticide	Traces	--

Note : All results are in mg/kg

ANNEX 2.12 (a) Dissolved Oxygen and Temperature Profile

(A) Vihar Lake

	Depth (m)	D.O. (mg/lit)	Temperature ^{O} C	D.O.(mg/lit)	Temperature ^{O} C	D.O. (mg/lit)	Temperature ^{O} C
1	0.5	--	--	7.6	31.7	7.8	25.2
2	1.0	8.8	25.9	7.5	31.6	7.7	25.1
3	2.0	8.7	25.8	7.3	31.3	7.5	25.0
4	3.0	8.0	25.7	6.6	30.8	7.0	24.8
5	4.0	7.9	25.6	5.7	30.6	6.9	24.7
6	5.0	7.7	25.2	1.5	29.5	6.7	24.4
7	6.0	6.8	25.1	1.3	28.5	6.5	24.2
8	7.0	6.2	24.9	0.9	26.4	6.3	24.0
9	8.0	6.0	24.9	0.7	26.1	6.1	24.0
10	9.0	--	--	0.5	26.0	--	--

(B) Tulsi lake

No.	Depth (meter)	Winter		Summer		Post Monsoon	
		D.O. (mg/lit)	Temperature ^{O} C	D.O.(mg/lit)	Temperature ^{O} C	D.O.(mg/lit)	Temperature ^{O} C
1.	0.5	--	--	7.7	31.2	8.4	24.8
2.	1.0	8.9	25.6	7.4	31.2	8.3	24.8
3.	2.0	8.5	25.6	7.1	31.1	8.1	24.7
4.	3.0	7.8	25.5	5.8	30.9	7.9	24.6
5.	4.0	6.9	25.3	1.9	29.5	7.3	24.4
6.	5.0	5.5	24.3	1.0	24.5	6.5	24.0
7.	6.0	2.5	23.9	0.9	24.2	6.3	23.9
8.	7.0	--	--	0.7	23.9	6.1	23.8
9.	8.0	--	--	0.6	23.6	--	--
10.	9.0	--	--	0.6	23.6	--	--

(C) Powai lake

No.	Depth (m)	Winter		Summer		Post Monsoon	
		D.O. (mg/lit)	Temperature ^{o} C	D.O.(mg/lit)	Temperature ^{o} C	D.O.(mg/lit)	Temperature ^{o} C
1.	0.5	--	--	6.2	31.9	7.5	25.5
2.	1.0	6.6	26.5	5.6	31.9	7.2	25.3
3.	1.5	--	--	5.4	31.9	6.8	25.1
4.	2.0	6.4	26.1	4.4	31.8	6.5	24.8
5.	2.5	--	--	2.9	31.7	6.1	24.6
6.	3.0	6.1	26.1	--	--	5.8	24.3
7.	4.0	3.9	26.0	--	--	--	--

ANNEX 2.13 Plankton Analysis Results of Lake

(A) Vihar Lake

No.	Organism	Mean	No. of individuals/ml	Group
1.	*Microcystis sp.*	8.2	74784	
2.	*Melosira sp.*	37.8	344736	C
3.	*Pediastrum sp.*	1	9120	C
4.	*Nitzschia sp.*	23.8	217056	C
5.	*Chrococcus sp.*	0.4	3648	
6.	*Fragellaria sp.*	17.2	156864	C
7.	Rotifer	1	9120	
8.	*Navicula sp.*	1.8	16416	C
9.	Ciliates	0.2	1824	A
10.	*Pinnularia sp.*	0.4	3648	C
11.	*Staurastrum sp.*	2.4	21888	D
12.	*Euglena sp.*	0.4	3648	B

Saprobic Index for the Vihar lake (X) = 1.02 (*β **meso-oligosaprobic condition of lake water)

(B) Tulsi Lake

No.	Organism	Total	Mean	Total/ml	Group
1.	*Microcystis sp.*	180	36	328320	
2.	*Pediastrum sp.*	6	1.2	10944	C
3.	*Chlorella sp.*	3	0.6	5472	C
4.	*Synedra sp.*	13	2.6	23712	C
5.	*Melosira sp.*	20	4	36480	C
6.	*Paramoecium sp.*	1	0.2	1824	A
7.	*Tetraspora sp.*	5	1	9120	C
8.	*Pinnularia sp.*	1	0.2	1824	C
9.	Rotifer	5	1.6	9120	
10.	*Peridinium sp.*	1	0.2	1824	D
11.	*Ceratium sp.*	8	1.6	14592	D
12.	Crustacean larvae	5	1	9120	
13.	*Nitzschia sp.*	7	1.4	12768	C
14.	*Daphnia sp.*	1	0.2	1824	
15.	*Staurastrum sp.*	1	0.2	1824	D

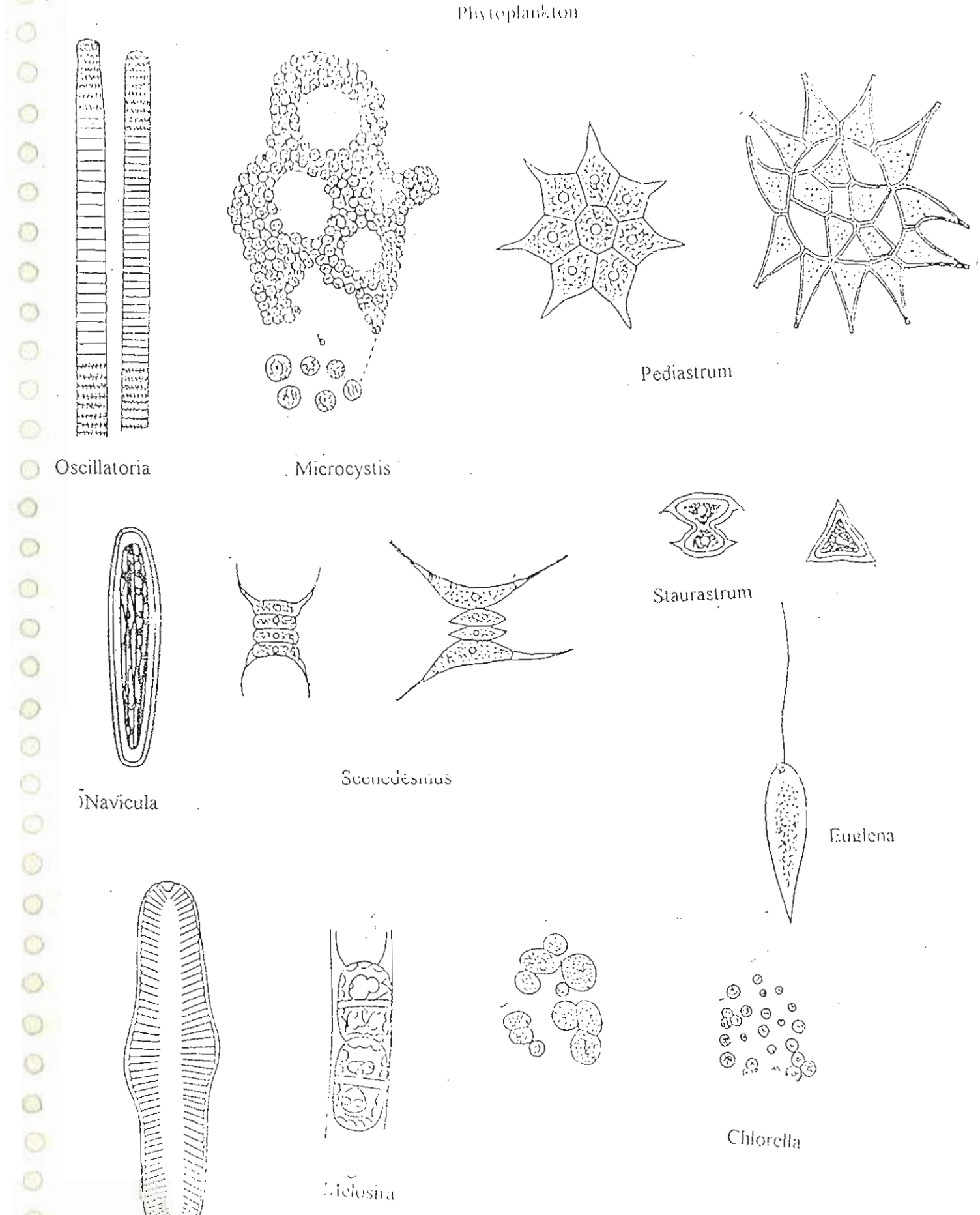
Saprobic Index for Tulsi lake: -

X = 1.1 i.e. β **meso-oligosaprobic** condition of lake water

(C) Powai Lake

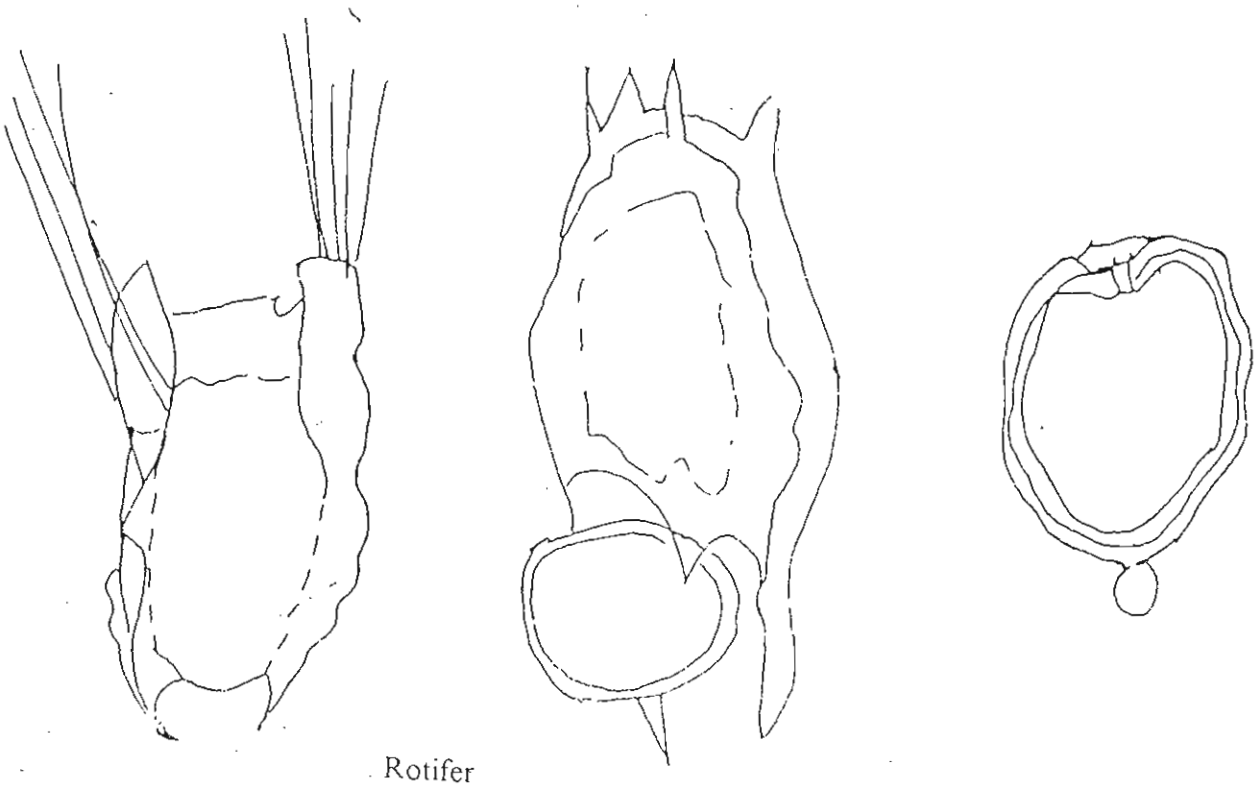
No.	Organism	Mean	No. of individuals/ml	Group
1.	*Nitzschia sp.*	120	1094400	C
2.	*Melosira sp.*	420	3830400	C
3.	*Daphnia sp.*	1.5	13680	
4.	*Pediastrum sp.*	1.5	13680	C
5.	*Nostoc sp.*	5.5	50160	
6.	*Fragellaria sp.*	14	127680	C
7.	Rotifer	0.5	4560	
8.	*Navicula sp.*	0.5	4560	C
9.	*Microcystis sp.*	0.5	4560	
10.	Ciliates	22.5	205200	A
11.	*Euglena sp.*	5	45600	B

Saprobic Index for Powai lake(X) = 0.83 i.e. β **mesosaprobic** condition of lake water suggesting more organic load in the lake water.

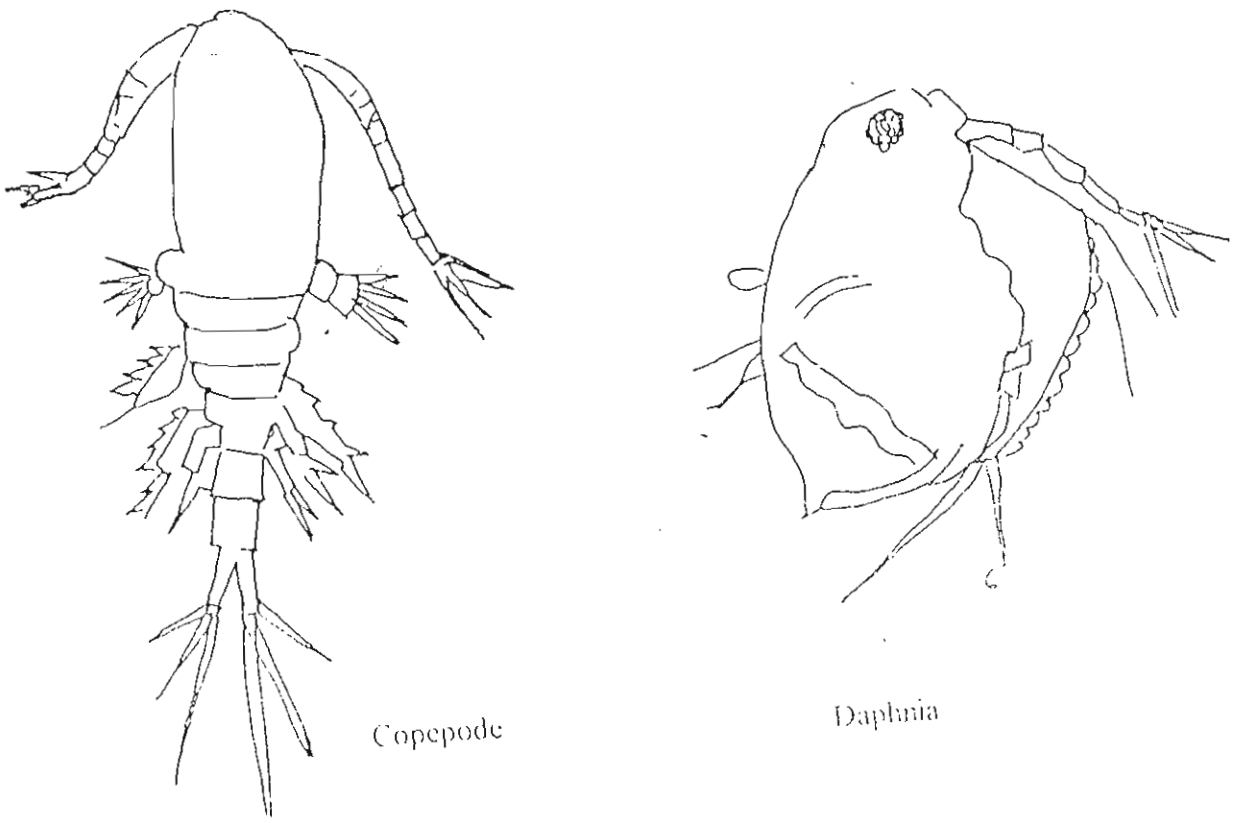


Annex 2.14 Diagrams of Phytoplanktons and Zooplanktons

Zooplankton



Rotifer



Copepode

Daphnia

ANNEX 2.15 List of Birds Observed During Lake Monitoring

No.	Common name –Scientific name	Vehar lake	Tulsi lake	Powai lake
1	Brahminy Kite – *Haliaststur indus*	+	+	+
2	Lesser Whistling Duck – *Denrocygna javanica*	+	--	--
3	River tern – *Sterna aurantia*	+	+	+
4	Gull Billed tern – *Gelochelidon nilotica*	--	--	+
5	Little Cormorant – *Phalacrocorax niger*	+	+	+
6	Indian Cormorant – *Phalacrocorax fascicollis*	--	--	+
7	Cattle egret – *Bubulcus ibis*	+	+	+
8	Indian Pond Heron – *Ardeola grayii*	+	+	+
9	Little egret –*Egretta garzetta*	+	+	+
10	Grey Heron – *Ardea cinerea*	--	--	+

ANNEX 2.16 Vegetation Mapping Results
(A) Place : Tulsi lake (Loghut)

Sr. No.	Name of Plant	Quadrat			Total No. of all individual	No. of Quadrat in which spp. occur	Frequency	Abundance	Density	Basal Area	Relative Frequency	Relative Density	Relative Dominance	IVI
		1	2	3										
1	*Tectona grandis* c	2	3	1	6	3	100.00	2.00	2.00	211.76	16.67	24.00	21.64	62.30
2	*Dendrocalamus strictus* c,e	3		3	6	2	66.67	3.00	2.00	463.05	11.11	24.00	47.32	82.43
3	*Spathodea campanulata* mc	1			1	1	33.33	1.00	0.33	18.47	5.56	4.00	1.89	11.44
4	*Morinda citrifolia* c,e,m		1	2	3	3	100.00	1.00	1.00	55.70	16.67	12.00	5.69	34.36
5	*Sapindus laurifolius*		1		1	1	33.33	1.00	0.33	22.29	5.56	4.00	2.28	11.83
6	*Mitragyna parvifolia* c,m		1		1	1	33.33	1.00	0.33	9.55	5.56	4.00	0.98	10.53
7	*Grewia tiliaefolia* e,m		1		1	1	33.33	1.00	0.33	14.96	5.56	4.00	1.53	11.08
8	*Wrightria tinctoria* c,m		1		1	1	33.33	1.00	0.33	12.73	5.56	4.00	1.30	10.86
9	*Garuga pinnata* c,e			1	1	1	33.33	1.00	0.33	18.31	5.56	4.00	1.87	11.43
10	*Ficus hispida* e,m			1	1	1	33.33	1.00	0.33	38.21	5.56	4.00	3.90	13.46
11	*Streblus asper* e,m			1	1	1	33.33	1.00	0.33	34.00	5.56	4.00	3.47	13.03
12	*Firmiana colarata* c			1	1	1	33.33	1.00	0.33	47.77	5.56	4.00	4.88	14.44
13	Paranga e,m,c		1		1	1	33.33	1.00	0.33	31.84	5.56	4.00	3.25	12.81
		6	**9**	**10**	**25**	**18**	**600.00**	**16.00**	**8.33**	**978.64**				

Economic Classification of Plants

e- edible m- medicinal **Reference: The useful plants of India (CSIR)**
d – domestic c - commercial

(B) Vihar Lake

Sr. No.	Name of Plant	Quadrat			Total No. of all individual	No. of Quadrat in which spp. occur	Frequency	Abundance	Density	Basal Area	Relative Frequency	Relative Density	Relative Dominance	IVI
		1	2	3										
1	*Holarrhena antidysenterica* m,c	5	4		9	2	66.67	4.50	3.00	24.46	9.09	17.31	4.52	30.92
2	*Carissa carandas* e,m	3	2	1	6	3	100.00	3.67	3.67	97.12	13.64	21.15	17.95	52.74
3	*Streblus asper* e,m	3	3		6	2	66.67	3.00	2.00	64.60	9.09	11.54	11.94	32.57
4	*Bombax ceiba* c,m	5			5	1	33.33	5.00	1.67	62.68	4.55	9.62	11.58	25.74
5	*Areca catechu* c,m	1	1		2	2	66.67	1.00	0.67	35.06	9.09	3.85	6.48	19.42
6	*Wrightria tinctoria* c,m	1	3		4	2	66.67	2.00	1.33	26.38	9.09	7.69	4.87	21.66
7	*Mitragyna parvifolia* c,m	1	1		2	2	66.67	1.00	0.67	52.42	9.09	3.85	9.69	22.62
8	*Tectona grandis* c	1			1	1	33.33	1.00	0.33	15.28	4.55	1.92	2.82	9.29
9	*Capparis spinosa*	1		3	4	2	66.67	2.00	1.33	19.40	9.09	7.69	3.58	20.37
10	*Firmiana colarata* c		1		1	1	33.33	1.00	0.33	5.40	4.55	1.92	1.00	7.47
11	*Cassia fistula* m,d			1	1	1	33.33	1.00	0.33	2.82	4.55	1.92	0.52	6.99
12	*Butea monosperma* m,d			3	3	1	33.33	3.00	1.00	23.80	4.55	5.77	4.40	14.71
13	*Garuga pinnata* c,e			2	2	1	33.33	2.00	0.67	64.00	4.55	3.85	11.83	20.22
14	Paranga e,m,c			1	1	1	33.33	1.00	0.33	47.76	4.55	1.92	8.83	15.29
		21	**15**	**11**	**47**	**22**	**733.33**	**31.17**	**17.33**	**541.18**				

(C) Sasunavghar

Sr. No.	Name of Plant	Quadrat 1	2	3	Total No. of all Individual	No. of Quadrat in which spp. occur	Frequency	Abundance	Density	Basal Area	Relative Frequency	Relative Density	Relative Dominance	IVI
1	*Mimosops hexandra* c,e	1		1	2	2	66.67	1.00	0.67	19.87	9.09	4.88	2.79	16.75
2	*Grewia tiliaefolia* e,m	1		2	3	2	66.67	1.50	1.00	20.00	9.09	7.32	2.80	19.21
3	*Schleichera oleosa* e,m	8	2	1	11	3	100.00	3.67	3.67	221.50	13.64	26.83	31.05	71.52
4	*Careya arborea* d	1			1	1	33.33	1.00	0.33	2.50	4.55	2.44	0.35	7.33
5	*Pterocarpus marsupium* m,c		1		1	1	33.33	1.00	0.33	63.68	4.55	2.44	8.93	15.91
6	*Mangifera indica* e		2		2	1	33.33	2.00	0.67	76.42	4.55	4.88	10.71	20.14
7	*Terminalia bellarica* c,m		1	4	5	2	66.67	2.50	1.67	134.21	9.09	12.20	18.82	40.10
8	*Spathodea campanulata* m,c			1	1	1	33.33	1.00	0.33	35.10	4.55	2.44	4.92	11.91
9	*Adina cordifolia* c			1	1	1	33.33	1.00	0.33	19.10	4.55	2.44	2.68	9.66
10	*Ficus hispida* e,m			1	1	1	33.33	1.00	0.33	19.10	4.55	2.44	2.68	9.66
11	*Saccopetalium tomantosa* c,e			3	3	1	33.33	3.00	1.00	6.62	4.55	7.32	0.93	12.79
12	*Glycosmis pentaphylla* m			2	2	1	33.33	2.00	0.67	4.44	4.55	4.88	0.62	10.05
13	*Lannea coromandelica*			2	2	1	33.33	2.00	0.67	11.72	4.55	4.88	1.64	11.07
14	*Madhuca indica* c,			2	2	1	33.33	2.00	0.67	33.32	4.55	4.88	4.67	14.09
15	*Ixora parviflora* e,m			1	1	1	33.33	1.00	0.33	15.28	4.55	2.44	2.14	9.13
16	*Zizypus mauritiana* e,m			2	2	1	33.33	2.00	0.67	3.71	4.55	4.88	0.52	9.94
17	*Diospyros melanoxylon* m,c			1	1	1	33.33	1.00	0.33	26.74	4.55	2.44	3.75	12.74
		11	**6**	**24**	**41**	**22**	**733.33**	**28.67**	**13.67**	**713.31**				

(D) Chenna East

Sr. No.	Name of Plant	Quadrat 1	2	3	Total No. of all	No. of Quadrat In which	Frequency	Abundance	Density	Basal Area	Relative Frequency	Relative Density	Relative Dominance	IVI
1	*Acacia catechu* c	8	1	1	10	3	100.00	3.33	3.33	19.87	13.04	25.00	4.53	42.58
2	*Bombax ceiba* e,m	1		1	2	2	66.67	1.00	0.67	60.88	8.70	5.00	13.89	27.59
3	*Hippocratea grahamii* e	1			1	1	33.33	1.00	0.33	20.68	4.35	2.50	4.72	11.57
4	*Morinda citrifolia* c,e,m	2			2	1	33.33	2.00	0.67	6.36	4.35	5.00	1.45	10.80
5	*Lannea coromandelica*	1			1	1	33.33	1.00	0.33	11.76	4.35	2.50	2.68	9.53
6	*Holarrhena antidysenterica* m,e		8	1	9	2	66.67	4.50	3.00	5.72	8.70	22.50	1.31	32.50
7	*Adina cordifolia* e		2		2	1	33.33	2.00	0.67	84.54	4.35	5.00	19.29	28.64
8	*Carissa carandas* e,m		2		2	1	33.33	2.00	0.67	31.82	4.35	5.00	7.26	16.61
9	*Ficus glomarata* e,m		1		1	1	33.33	1.00	0.33	15.26	4.35	2.50	3.48	10.33
10	*Calycopteris floribunda* m		1	1	2	2	66.67	1.00	0.67	10.50	8.70	5.00	2.40	16.09
11	*Wrightria tinctoria* c,m		1		1	1	33.33	1.00	0.33	12.72	4.35	2.50	2.90	9.75
12	*Albizia procera* c		1		1	1	33.33	1.00	0.33	25.46	4.35	2.50	5.81	12.66
13	*Zizypus mauritiana* e,m		1		1	1	33.33	1.00	0.33	20.38	4.35	2.50	4.65	11.50
14	*Terminalia belarica* c,m			1	1	1	33.33	1.00	0.33	63.68	4.35	2.50	14.53	21.38
15	*Saccopetalium tomantosa* c,e			1	1	1	33.33	1.00	0.33	43.30	4.35	2.50	9.88	16.73
16	*Trewia nudiflora* c,m,e			1	1	1	33.33	1.00	0.33	1.80	4.35	2.50	0.41	7.26
17	*Streblus asper* e,m			1	1	1	33.33	1.00	0.33	2.54	4.35	2.50	0.58	7.43
18	*Cassia fistula* m,d			1	1	1	33.33	1.00	0.33	0.94	4.35	2.50	0.21	7.06
		13	**18**	**9**	**40**	**23**	**766.67**	**26.83**	**13.33**	**438.21**	**195.65**			

(E) Yeur West

Sr. No.	Name of Plant	Quadrat			Total No. of all individual	No. of Quadrat in which spp. occur	Frequency	Abundance	Density	Basal Area	Relative Frequency	Relative Density	Relative Dominance	IVI
		1	2	3										
1	*Adina cordifolia* c	3		1	4	2	66.67	2.00	1.33	67.48	6.90	0.22	11.28	18.40
2	*Glycosmis pentaphylla* m	2			2	1	33.33	2.00	0.67	7.62	3.45	0.11	1.27	4.83
3	*Wrightria tinctoria* c, m	2	2	2	6	3	100.00	2.00	2.00	70.96	10.34	0.33	11.86	22.54
4	*Tectona grandis* c	3	1	2	6	3	100.00	2.00	2.00	156.00	10.34	0.33	26.08	36.76
5	*Pterocarpus marsupium* c, m	1			1	1	33.33	1.00	0.33	13.36	3.45	0.06	2.23	5.74
6	*Saccopetalium tomantosa*	1	1		2	2	66.67	1.00	0.67	14.92	6.90	0.11	2.49	9.50
7	*Carissa carandas* c, e, m	1	1		2	2	66.67	1.00	0.67	8.90	6.90	0.11	1.49	8.50
8	*Trewia nudiflora* c, m, e	1			1	1	33.33	1.00	0.33	5.40	3.45	0.06	0.90	4.41
9	*Dendrocalamus strictus*	1			1	1	33.33	1.00	0.33	47.12	3.45	0.06	7.88	11.38
10	*Leea macrophylla* c, e, m		2		2	1	33.33	2.00	0.67	10.16	3.45	0.11	1.70	5.26
11	*Grewia tiliaefolia* e, m		1		1	1	33.33	1.00	0.33	28.66	3.45	0.06	4.79	8.30
12	*Terminalia tomentosa* c, m		1		1	1	33.33	1.00	0.33	7.10	3.45	0.06	1.19	4.69
13	*Spondias mangifera*		2		2	1	33.33	2.00	0.67	8.88	3.45	0.11	1.48	5.04
14	*Cassia fistula* m, d		1		1	1	33.33	1.00	0.33	7.96	3.45	0.06	1.33	4.83
15	*Butea monosperma* m, d		3		3	1	33.33	3.00	1.00	25.28	3.45	0.17	4.23	7.84
16	*Falcourtia sepiaria*		1		1	1	33.33	1.00	0.33	17.50	3.45	0.06	2.93	6.43
17	*Calycopteris floribunda* m		2	1	3	2	66.67	1.50	1.00	13.34	6.90	0.17	2.23	9.29
18	*Garuga pinnata* c, e			1	1	1	33.33	1.00	0.33	28.66	3.45	0.06	4.79	8.30
19	*Terminalia belarica* c, m			1	1	1	33.33	1.00	0.33	23.88	3.45	0.06	3.99	7.50
20	*Holarrhena antidysenterica* m			1	1	1	33.33	1.00	0.33	1.90	3.45	0.06	0.32	3.82
21	*Madhuca indica* c			1	1	1	33.33	1.00	0.33	33.12	3.45	0.06	5.54	9.04
		15	18	10	43	29	966.67	29.50	14.33	598.20				

(F) Encroachment Area (*Near Gautam Nagar*)

Sr. No.	Name of Plant	Quadrat 1	2	3	Total No. of all individual	No. of Quadrat in which spp. occur	Frequency	Abundance	Density	Basal Area	Relative Frequency	Relative Density	Relative Dominance	IVI
1	*Zyzipus xylopyra* c, d	6		4	10	2	66.67	5.00	3.33	65.72	4.65	9.52	7.52	21.69
2	*Carissa carandas* e, m	3	6	1	10	3	100.00	3.33	3.33	189.70	6.98	9.52	21.71	38.21
3	*Firmiana colarata* c	1	1		2	2	66.67	1.00	0.67	21.94	4.65	1.90	2.51	9.07
4	*Bhauhnia spp.* m	3	1		4	2	66.67	2.00	1.33	22.58	4.65	3.81	2.58	11.04
5	*Grewia tiliaefolia* e, m	2	1	8	11	3	100.00	3.67	3.67	39.76	6.98	10.48	4.55	22.00
6	*Carvia callosa* c	1			1	1	33.33	1.00	0.33	4.76	2.33	0.95	0.54	3.82
7	*Hacourtia sepiaria*	1	3		4	2	66.67	2.00	1.33	28.20	4.65	3.81	3.23	11.69
8	*Bridelia retusa* c, e, m	1		3	4	2	66.67	2.00	1.33	33.67	4.65	3.81	3.85	12.31
9	*Gardenia turgida* e, m, c	3		1	4	2	66.67	2.00	1.33	30.52	4.65	3.81	3.49	11.95
10	*Lannea coromandelica*	1			1	1	33.33	1.00	0.33	8.28	2.33	0.95	0.95	4.23
11	*Dendrocalamus strictus* c, e	4			4	1	33.33	4.00	1.33	120.99	2.33	3.81	13.84	19.98
12	*Holarrhena antidysenterica* m, c	2		1	3	2	66.67	1.50	1.00	9.22	4.65	2.86	1.05	8.56
13	*Bombax ceiba* c, m	4	2		6	2	66.67	3.00	2.00	32.12	4.65	5.71	3.68	14.04
14	*Madhuca indica* c	2			2	1	33.33	2.00	0.67	8.90	2.33	1.90	1.02	5.25
15	*Glycosmis pentaphylla* m		2	3	5	2	66.67	2.50	1.67	27.98	4.65	4.76	3.20	12.61
16	*Calycopteris floribunda* m		1	2	3	2	66.67	1.50	1.00	45.46	4.65	2.86	5.20	12.71
17	*Saccopotaium tomentosa* c, e		1		1	1	33.33	1.00	0.33	1.26	2.33	0.95	0.14	3.42
18	*Morinda citrifolia* c, e, m		4	2	6	2	66.67	3.00	2.00	50.98	4.65	5.71	5.83	16.20
19	*Terminalia belarica* c, m		2	3	5	2	66.67	2.50	1.67	35.96	4.65	4.76	4.11	13.53
20	*Careya arborea* d		4	2	6	2	66.67	3.00	2.00	30.52	4.65	5.71	3.49	13.86
21	*Garuga pinnata* c, e			1	1	1	33.33	1.00	0.33	6.36	2.33	0.95	0.73	4.01

22	*Terwia nudiflora* c,m,e		2	4	6	2	66.67	3.00	2.00	30.42	4.65	5.71	3.48	13.85
23	*Dalbergia sisso* c			2	2	1	33.33	2.00	0.67	12.72	2.33	1.90	1.46	5.69
24	*Buchanania lanzan* e,m			1	1	1	33.33	1.00	0.33	5.72	2.33	0.95	0.65	3.93
25	*Sideroxylon tomentosum* e,m,c			3	3	1	33.33	3.00	1.00	10.22	2.33	2.86	1.17	6.35
		34	**30**	**41**	**105**	**43**	**1433.33**	**57.00**	**35.00**	**873.96**				

Calculations and brief description of the parameters calculated are as follows –

A)Frequency- Frequency is defined as the chance of finding a species in a particular area in a particular sample. Frequency indicates the level of homogeneity of distribution of a species, in the area of study. High frequency value – more homogenous.

$$\text{Frequency} = \frac{\text{Number of sampling units (quadrats) in which sps. Occurred X 100}}{\text{Total number of units studied}}$$

B) Abundance- This represents the numerical strength of species in the community. Abundance if considered along with frequency and gives an idea of the distribution pattern of the species.

$$\text{Abundance} = \frac{\text{Total number of individuals}}{\text{Number of quadrats of occurrence}}$$

C) Density- Density is nothing but the number of individuals of a particular species per unit area.

$$\text{Density} = \frac{\text{Total number of individuals}}{\text{Total number of quadrats studied}}$$

D) Relative Dominance = Total basal area of the species X 100
Total basal area of all species.

Area occupied by a species compared with others.

E) Relative Density = Number of individuals of the species X 100
Number of individuals of all species.

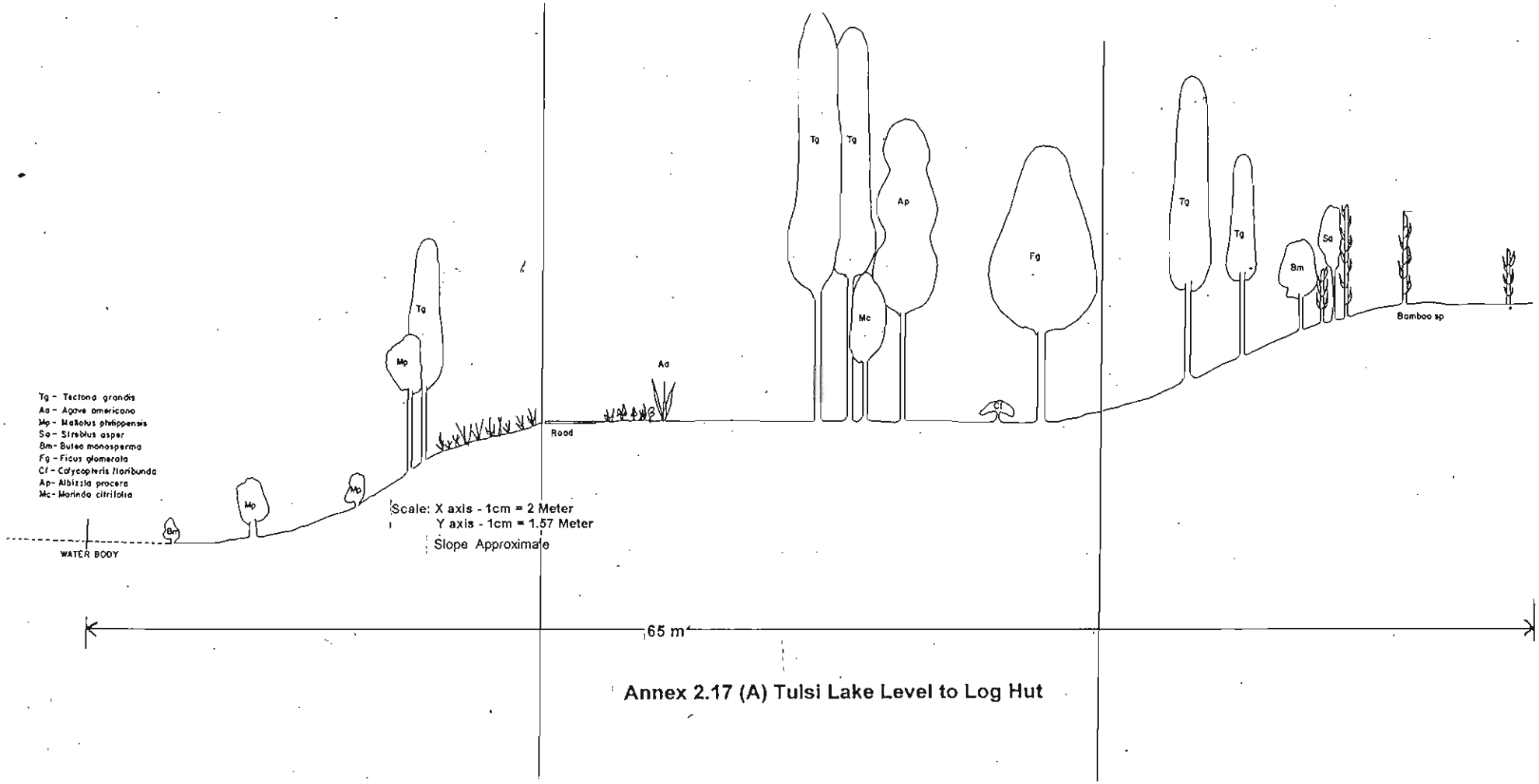
Density of species on comparative basis.

F) Relative Frequency = Number of occurrences of the species X 100
Number of occurrences of all species.

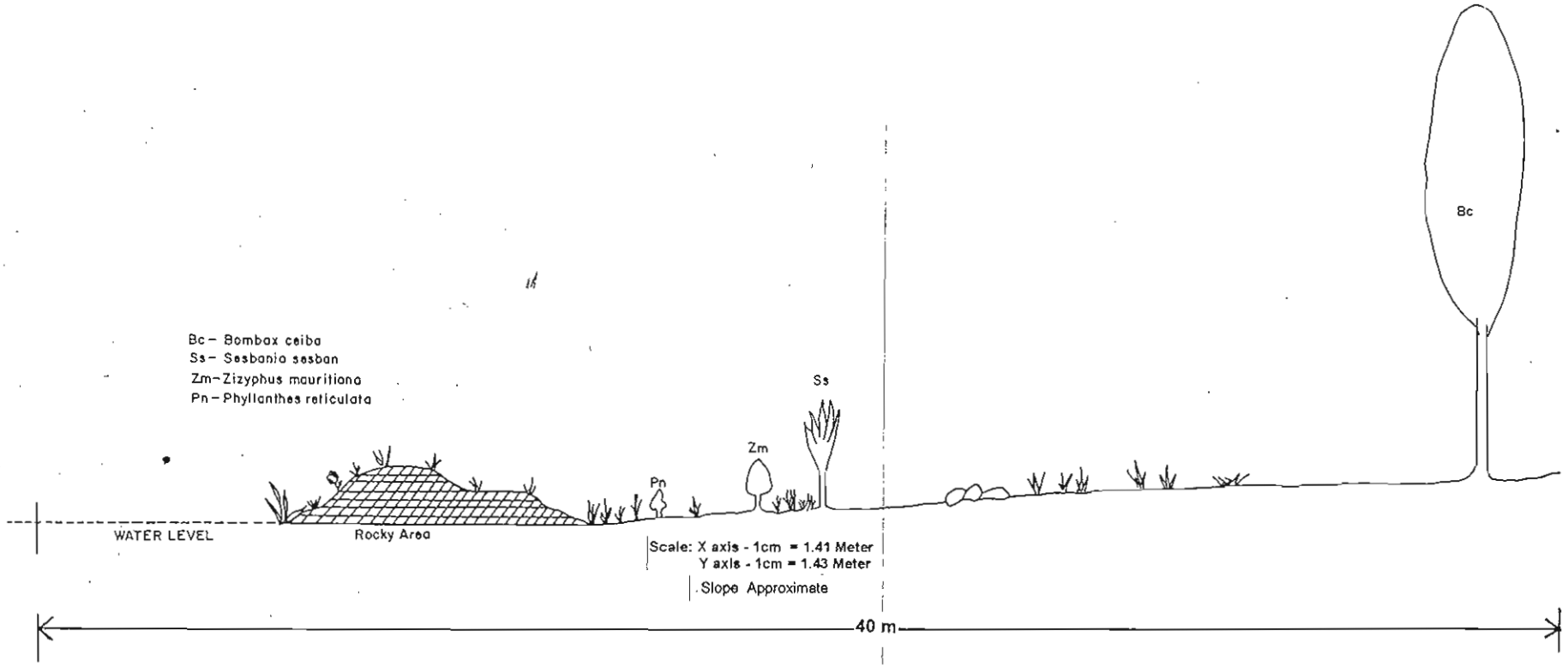
Level of homogenous distribution of species, on comparative basis.

G) Important Value Index = Relative Dominance + Relative Density
+ Relative frequency

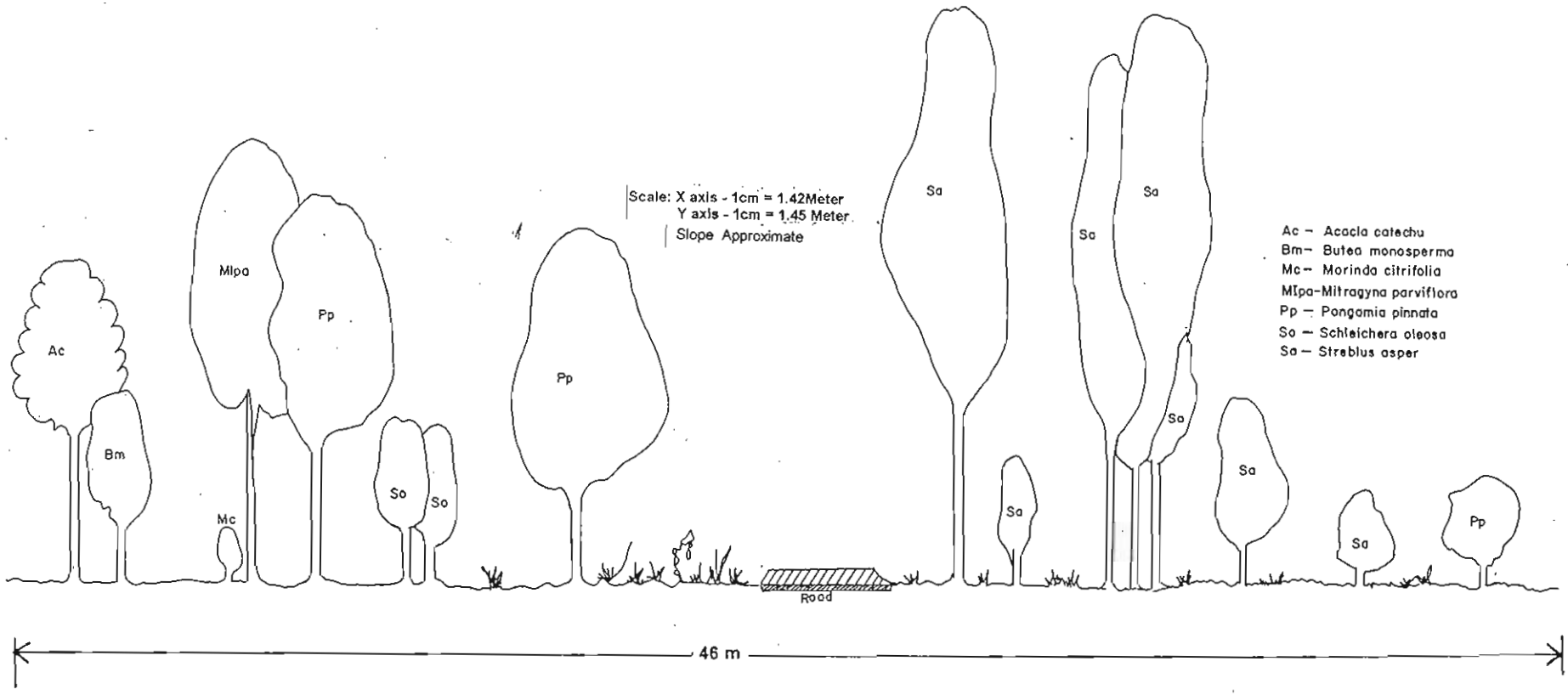
Importance of a species in plant community. High IVI – More important species.



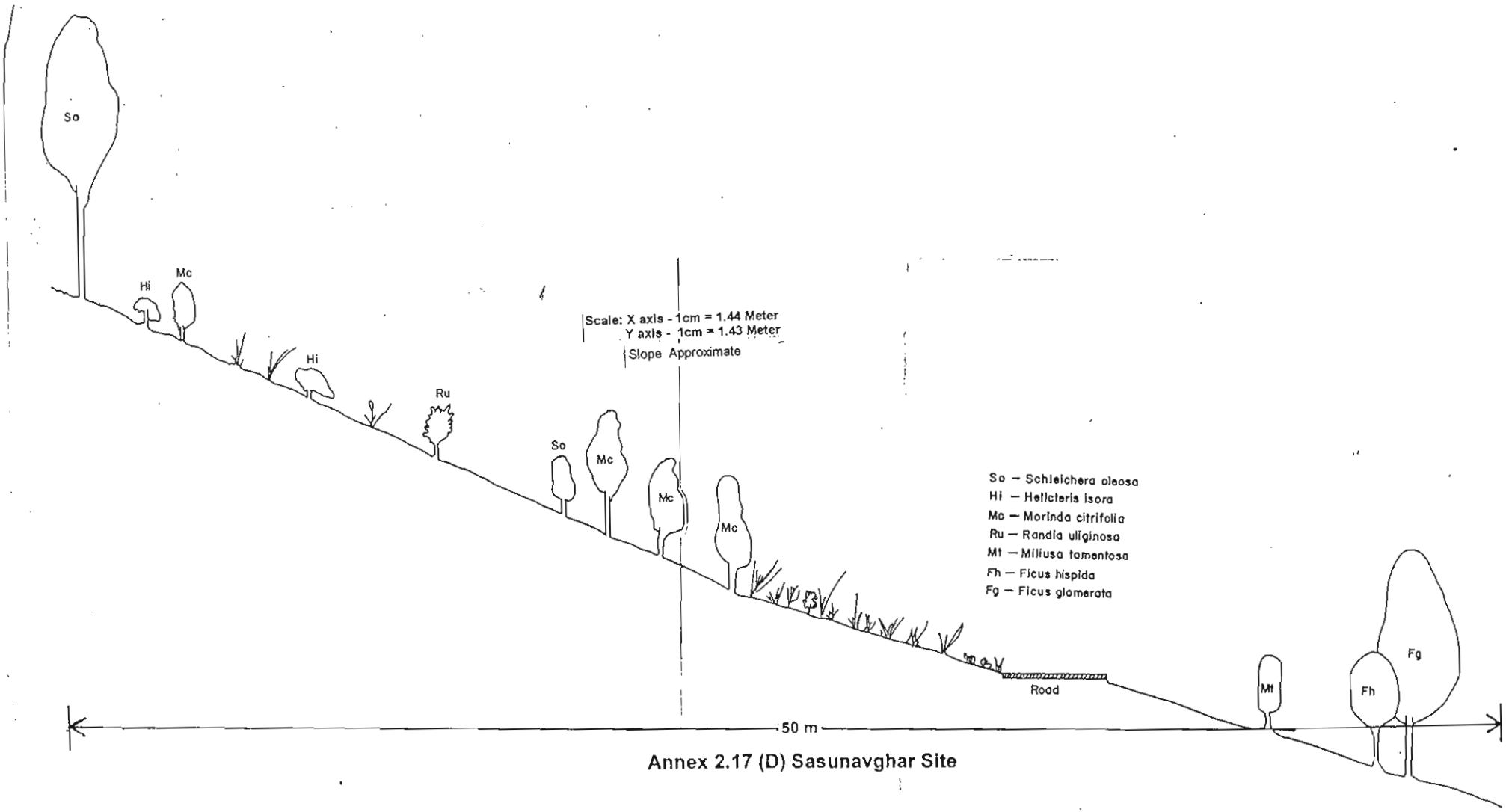
Annex 2.17 (A) Tulsi Lake Level to Log Hut



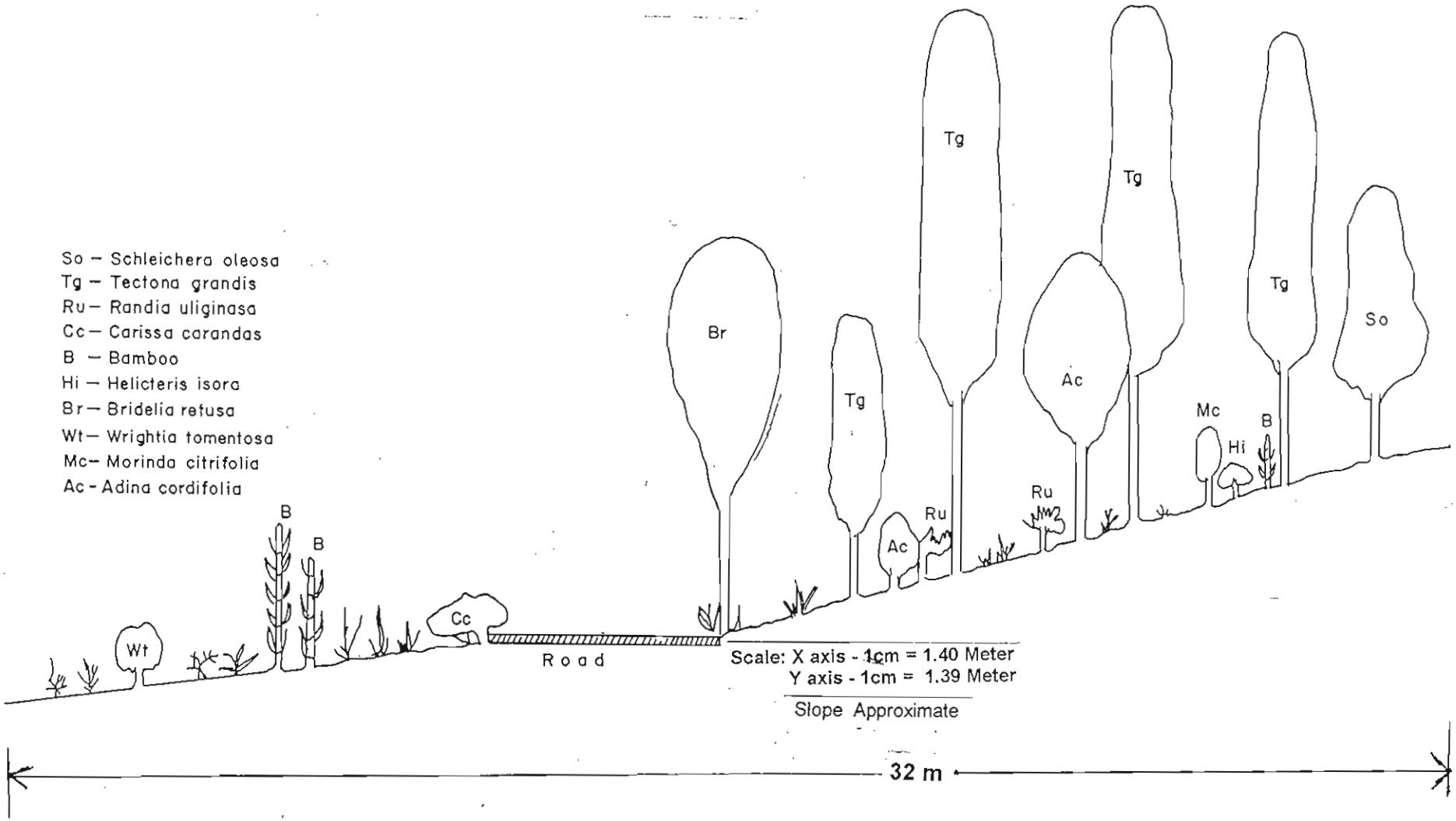
Annex 2.17 (B) Shore of Tulsi Lake



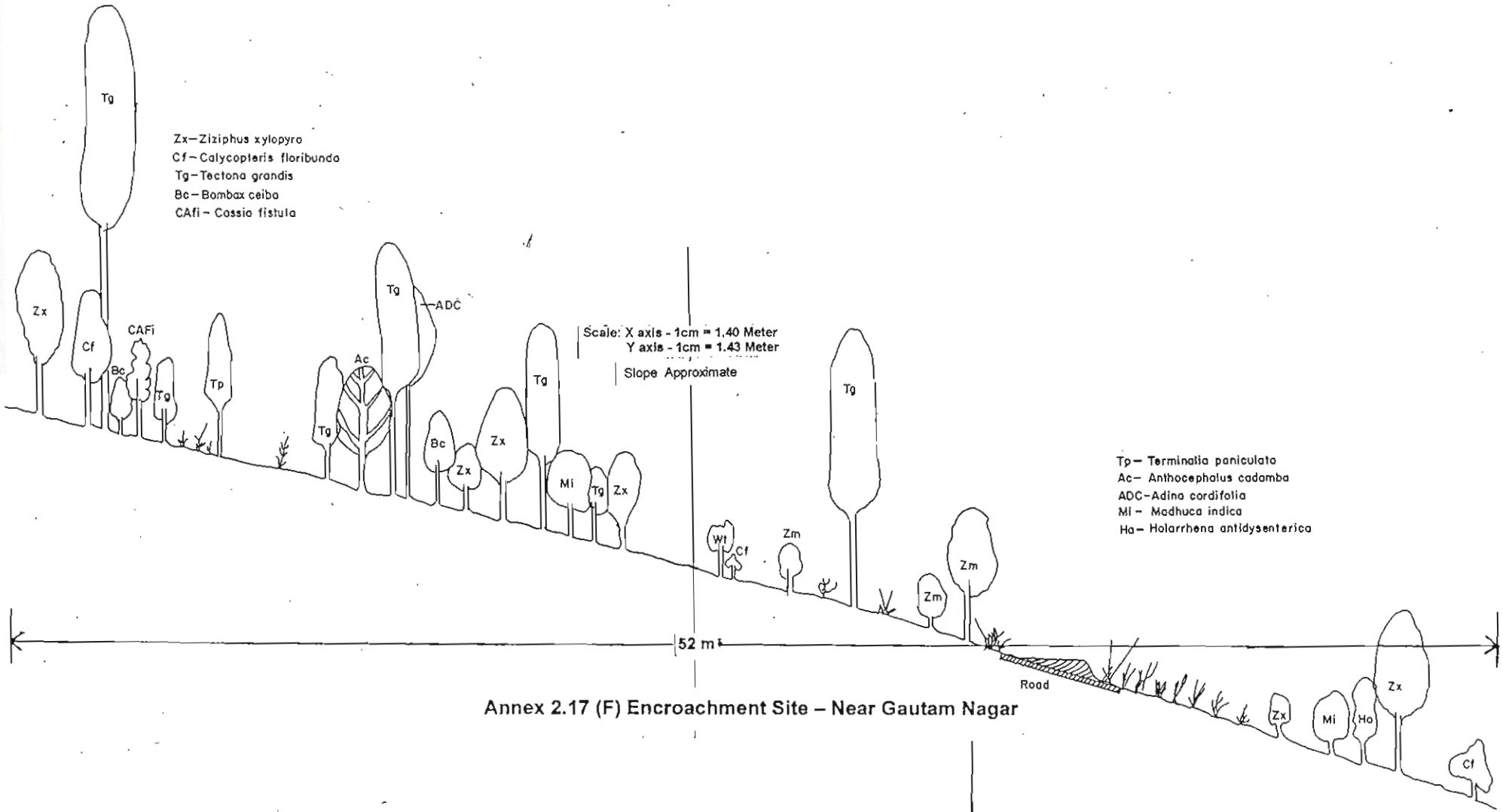
Annex 2.17 (C) Vihar Lake, Mori No. 19



Annex 2.17 (D) Sasunavghar Site



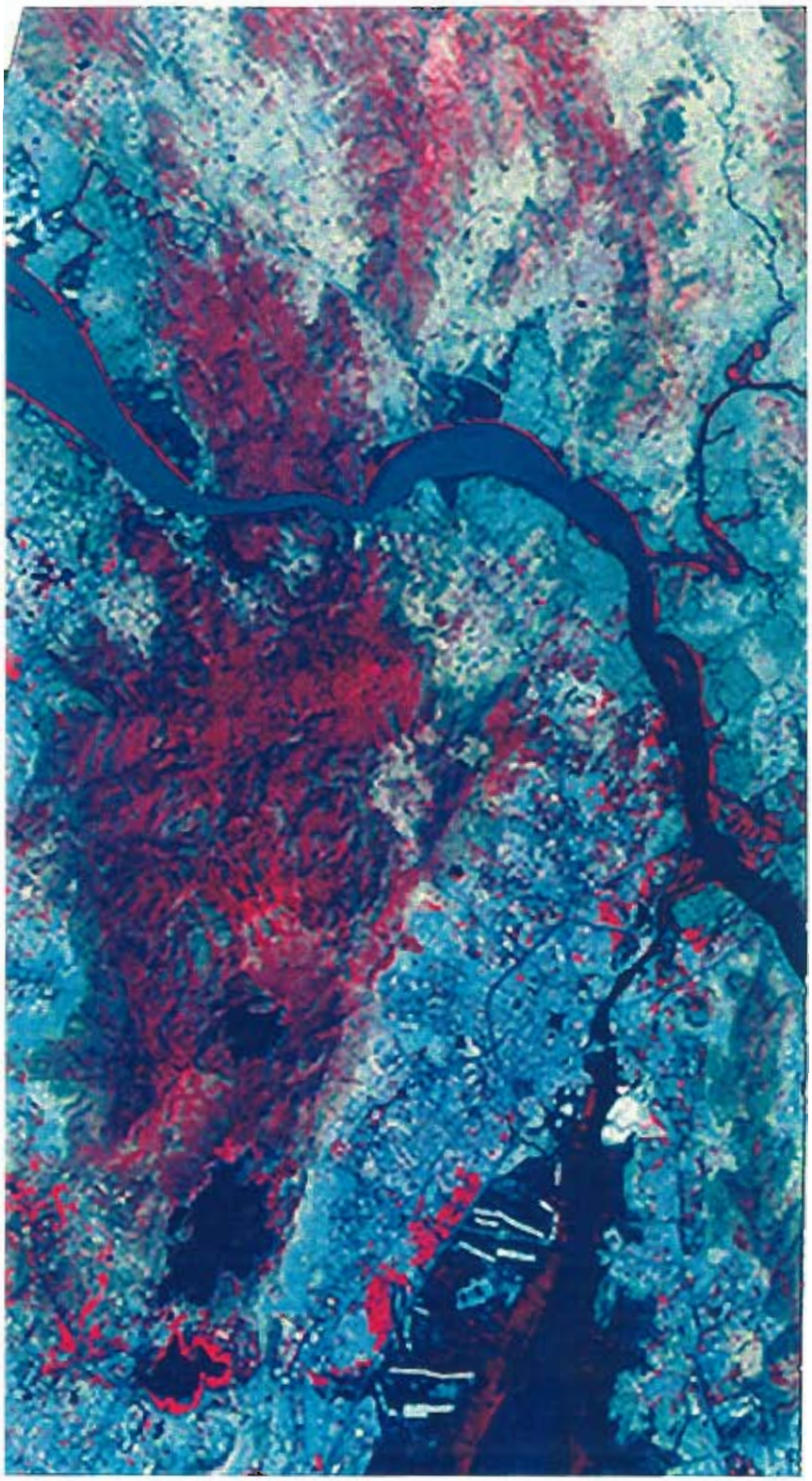
Annex 2.17 (E) Yeur (West) Site



Annex 2.17 (F) Encroachment Site – Near Gautam Nagar

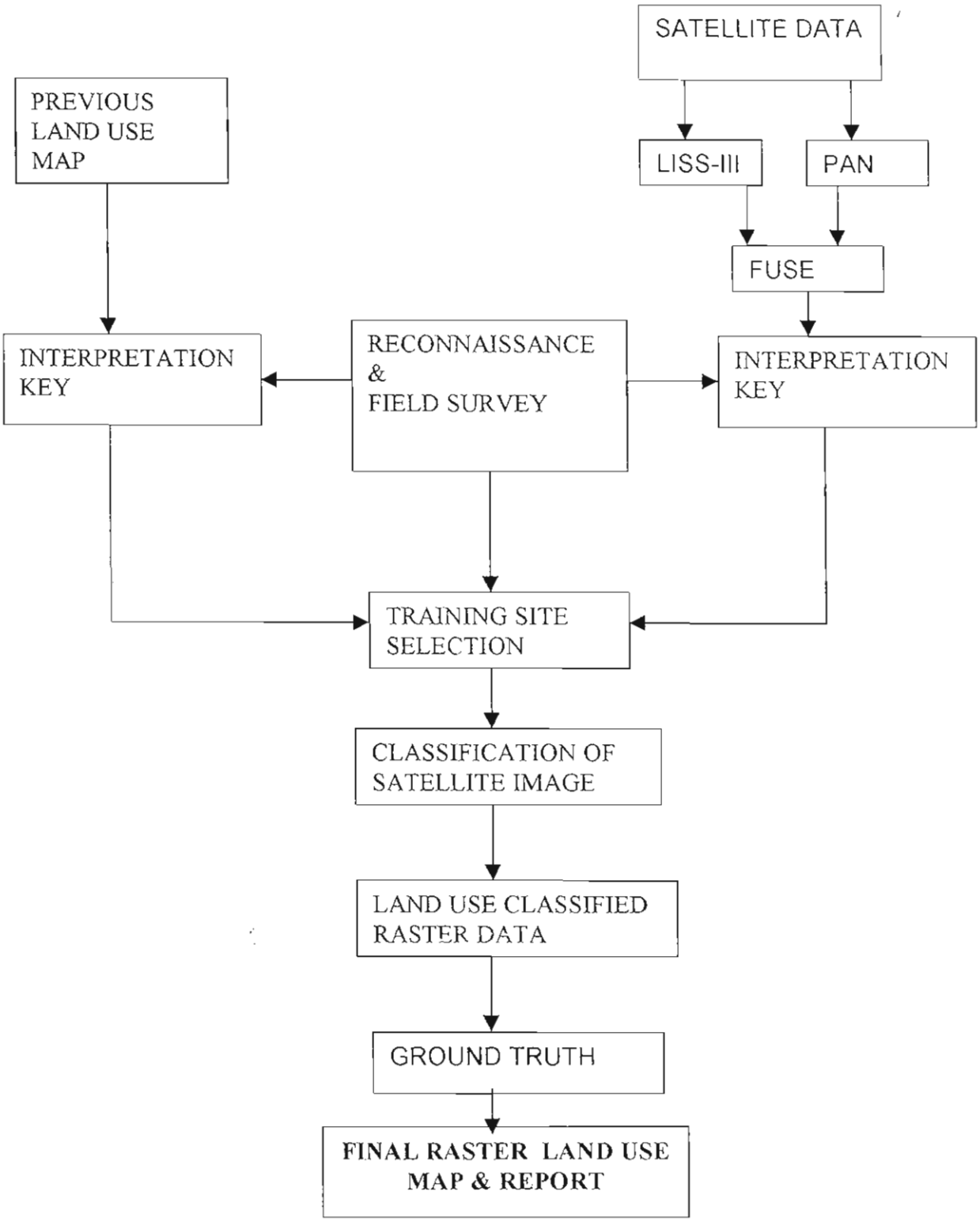
ANNEX 2.18 Soil Analysis Results

Location	Season	pH (1:5 solution)	Electrical Conductivity (µS/cm)	Total Nitrogen %	Phosphorus %	Potassium %	Chlorides %	Organic matter %	Lead (mg/kg)
Aakurli	Summer	5.5	475	0.064	0.0075	0.017	0.002	2.06	1.3
	Post monsoon	6.0	39.8	0.084	0.028	0.063	0.003	1.03	2.4
Chenna	Summer	7.25	805	0.082	0.023	0.048	0.004	3.1	1.1
	Post monsoon	6.8	25.7	0.067	0.18	0.028	0.0058	1.8	7.1
Sasunavghar	Summer	7.3	750	0.073	0.0053	0.045	0.006	1.55	0.43
	Post monsoon	6.4	58.0	0.12	0.092	0.029	0.0068	3.8	2.5
Tulsi	Summer	7.8	95	0.073	0.0068	0.0430	0.003	0.52	0.43
	Post monsoon	6.41	70.0	0.042	0.17	0.362	0.0039	9.0	2.3
Vihar	Summer	7.4	32	0.087	0.011	0.028	0.002	2.33	0.92
	Post monsoon	6.0	39.8	0.056	0.029	0.0441	0.003	0.77	2.4
Yeur	Summer	7.48	515	0.079	0.00975	0.058	0.003	8.3	2.09
	Post monsoon	6.10	34.5	0.32	0.17	0.015	0.003	4.4	4.9



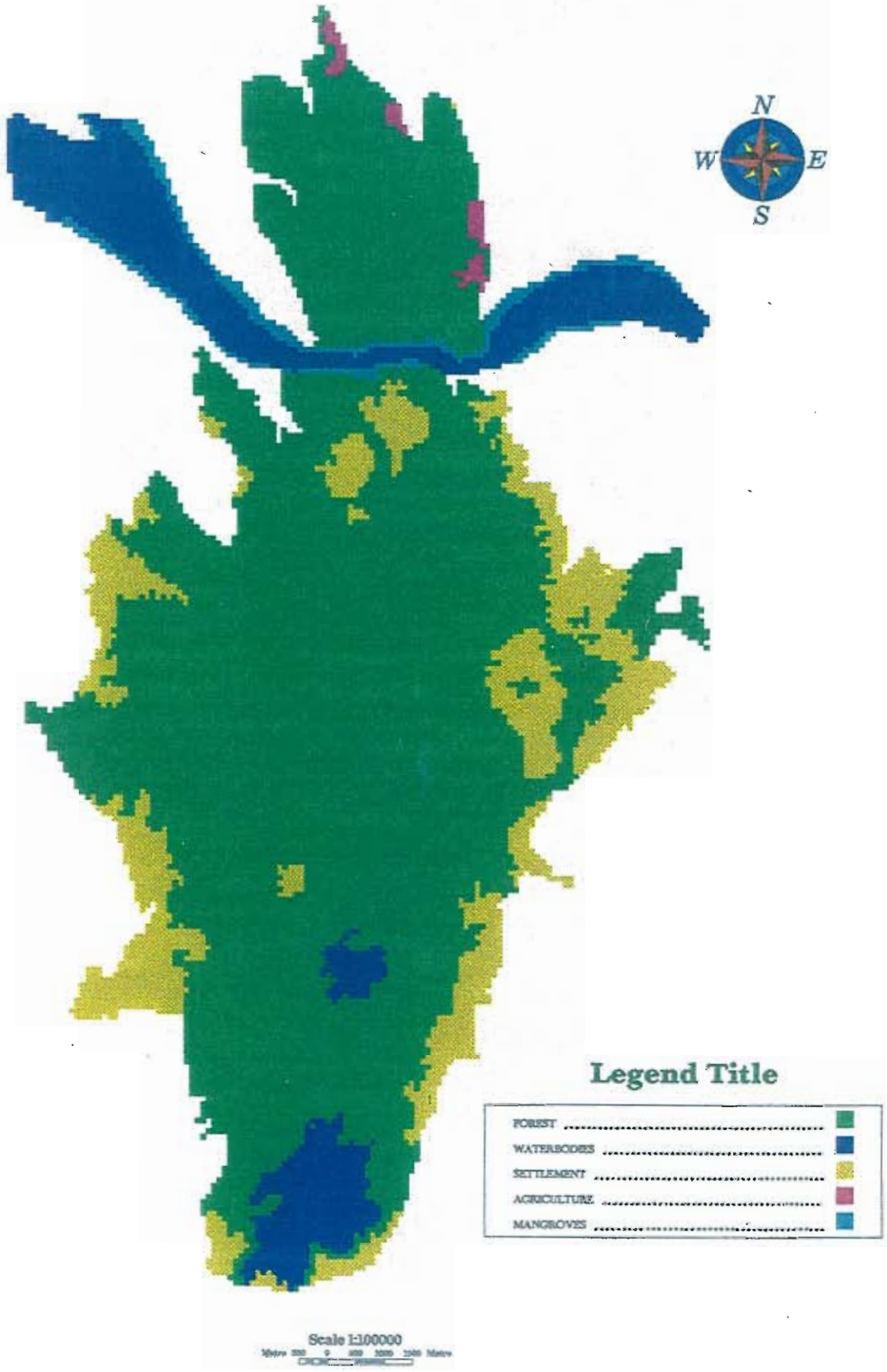
SERENE ENVIRONMENTAL SERVICES
Annex 2.19 MERGED LISS III + PAN SATELLITE IMAGE OF SCNP
CLIENT : MMR-ENVIRONMENT IMPROVEMENT SOCIETY

ANNEX 2.20 LAND USE MAPPING METHYODOLOGY :



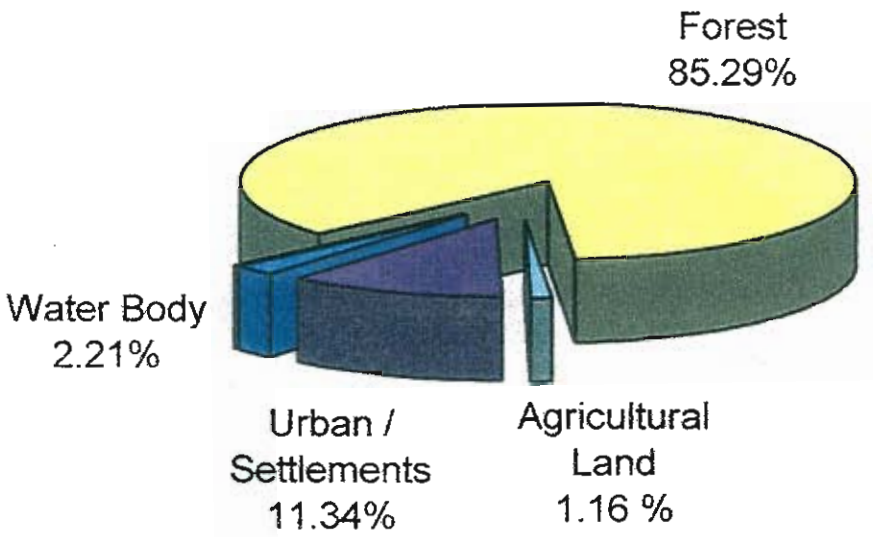
ANNEX-2. 21

LAND USE MAP OF SGNP, BORIWALI, MUMBAI



ANNEX 2.22

Landuse Classification of Sanjay Gandhi National Park



ANNEX 3.1 – PLANTATION IN ABANDONED QUARRY

The species proposed for plantation, as green barriers shall have following properties:

- They should be fast growing to have optimum penetrability.
- They should be deep rooted to be firm against wind blows
- They should be draught resistant.

They should have dense canopy because the gaps in the canopy will act as wind tunnels.

They should also form abundant litter on the floor to improve the soil quality. The following species could be planted in the mine pit areas:

- Lucaenea leucocephala (Subabool)
- Terminalia catapa (Country Almond)
- Terminalia arjuna (Arjun)
- Ficus religiosa (Pipal)
- Ficus glomerata Roxb (Gular)
- Pterospermum acerifolium (Muchkund)
- Sapindus tofoliatus (Ritha)
- Acasia nilotica (Acasia)
- Albizzia lebeck (Dirisinum)
- Azadirachta indica (Neem)
- Pongamia clabra (Karanj)
- Mangipera indica (Mango).
- Ombax ceiba (Silk Cotton)
- Ficus glomerata (Wild Fig)
- Syzygium cumini (Jamun)
- Bmbusa bambus (Bamboo)
- Dalbergia latifolia Roxb.(Shisam)
- Dalbergia lanceolaria Linn (Hardi)
- Largerstroemia parviflora Roxb (Lendia)
- Lennea coromandelica Houtt (Jhingan)
- Madhuca omdoca Gmel (Mahua)
- Grasses of different types, esp. on thin soils.

Among the species suggested, subabool stands excellent for dust filtering based on its height, quick growth, leaf density and draught tolerance. The next preferred species is Country Almond. Though the leaf density of this tree is less compared to Subabool, the growth rates are moderately vigorous. Arjuna has moderate leaf density but it's average heights is more.

In addition to plantation proposed as explained above. Green belt development is also proposed along the roadsides in order to improve the aesthetics of the area.

Type of species proposed for roadside plantation are

- Albizzia procera Benth (Safed Siris)
- Cassia siamea
- Polyathia longifolia (Dropping Ashoka).
- Pongamia pinnata Linn (Karanj)
- Terminalia tomentosa (Asna)

ANNEX 3.2 ENVIRONMENTAL MANAGEMENT PLAN FOR QUARRY OPERATIONS

Quarry operations carried out in a haphazard and indiscriminate manner can result in the degradation of environmental quality of the area, specially the land use pattern. Moreover, handling and transportation of rocks/soils could pose air pollution problems. Movements of vehicles can cause noise nuisance in the surrounding area. Natural drainage of the area could be disrupted causing water logging and silt deposition in natural water courses if present in the vicinity. Thus, adequate environmental management measures need to be incorporated during the pre-quarrying, quarrying and post-quarrying operations at the study area.

Environmental Management Plan needs to be prepared and implemented by all quarry operators, which should be evaluated by the District Collector and DGMS. At a minimum, the following actions should be incorporated into the EMP for pollution mitigation:

Air pollution control:

Quarrying activity in SGNP area is causing serious air pollution and other problems in the vicinity. Various activities contributing to dust pollution include drilling, blasting, stone loading and unloading operations, stone crushing and movement of dumpers in the quarry. Obnoxious gases are also likely to be emitted on account of incomplete detonation during blasting operations.

Fugitive dust emitted from mining operations affect the safety and performance of workers, substantially lowers efficiency of mechanical equipment besides causing heavy wear and tear which has an adverse effect on productivity. Dust and obnoxious gases dispersing outside the mines has effects on crop yield, flora, fauna and social environment. The following measures should be taken to minimise air pollution in the quarry.

- Wet drilling at the mining site.
- Minimise drop height during loading and unloading operations.
- Water sprinkling on active mine face and on haulage road at the rate of 65 lit /hr per loader / excavator / tipper operation. This will reduce fugitive dust emission by about 80 %. In order to resort to water sprinkling during tipper movement, sprinklers with water tank may be fitted at the rear end of the tippers.
- Hosing down of wheels of vehicles used in the mining area to ensure and minimise dust carry over through wheels.
- Construction of speed breakers on quarry floor and / or attachment of speed locking system to the accelerators of all vehicles used for maintaining a speed limit of 20 km/h.
- Water sprinkling at material transfer points in stone crushers. Plantation along the quarry periphery to arrest the flow of dust along with wind.
- Ensure that all vehicles used in mining have PUC Certificate.

Noise and vibration control:

The relevant noise emitters in the quarries are mining machinery and blasting operation. While blasting produces impulsive noise, other mining operations involving various mining equipment produce continuous noise. Continuous noise of crusher is a nuisance often extending to over 200m. around the soure. The blasting operations are right at the forest boundary and have a very significant impact on the wildlife and are also affecting the stability of slopes at Forest Boundary. Several cracks have been observed at the forest boundary near the blasting sites (See **Chapter 6** for details).

Following measures should be incorporated for controlling noise level impacts and ground vibrations:

- Proper lubrication and regular maintenance of all the mining machinery used.
- Providing wireless sets to all the machine operators and supervisory staff for effective communication.
- Development of greenery / barriers / landscaping of trees / bushes and shrubs.
- Reduced noise exposure to the operators of mining machinery by work scheduling and by providing ear protective equipment
- Use of controlled blasting technique wherever required using non-electric initiation system such as Nonel & Raydet for controlling noise and ground vibrations produced on account of blasting.
- Use of long stemming columns in blast holes. Proper design of blasting parameters should be arrived at after monitoring the actual ground vibration results occurring due to blasting carried out on the basis of theoretical designs.
- No blasting shall be carried out when strong winds are blowing towards population centres / villages or when the sky is cloudy. Cloud covers causes reflection of pressure wave back to the ground thereby increasing noise level.
- Blasting to be carried out at mid day and never at night.

Control of fly rocks

On account of blasting operations, rocks get fragmented and are then moved forward to make mucking of the fragmented mass easier and less costly. In addition to this desirable displacement of broken fragments in case of surface blasting operation, some stone pieces get torn and fly to very large distance on account of inadequate burden and spacing, overloading of holes, inaccurate drilling, inaccurate and inadequate stemming and faulty delay timing and initiation sequence. This unexpected projection of stone termed as fly rock has an accident potential and hence has an environmental impact in case it is not controlled. Hence following measures are proposed for fly rock control:

- Proper design of blast hole i.e. burden, spacing, depth and charge to utilise explosive energy to the maximum extent possible.
- Proper timing and initiation sequence of controlled blasting.
- Use of low-density explosives for blasting.

- Stemming of holes by drill cuttings to avoid premature blow of explosion gases.
- Provision of proper length of stemming typically 40 times blast hole diameter.
- Checking of blast hole inclination for accurate burden before charging of holes.
- Proper cleaning of blasting site before detonation to avoid hidden boulders at or near the blast site to become air borne.

Disaster Management Planning

Loss of human life, fauna species due to blasting and due to accidental falling in mining pit and during transportation / handling of explosives are the general risks associated with any quarry/mining operation. The following measures should be taken for minimising the chances and impact of any such disasters:

- Approach road to the mine shall be provided with the signboards informing of the movement of heavy earth moving machinery, speed control etc.
- Storage, transportation and handling of explosive will be carried out strictly in accordance with the provisions of rules made under the Indian Explosive Act-1884.
- Explosives will be kept in Magazine duly approved by the licensing authority under the Indian Explosive Act-1884.
- Every magazine/store/premise where explosives are proposed to be stored will be under a competent person, who will be responsible for the proper receipt, storage and issue of explosives.
- Explosives will be issued only to competent persons upon written requisition by a competent person duly authorised for the purpose.
- Persons engaged in handling explosives and/or engaged in preparation of charges, charging of holes will not be allowed to carry or use light other than electric torch.
- Only competent persons will be allowed to visit the mine face after blasting.
- The Blaster will ensure that all the persons in the vicinity of blasting site have taken proper shelter before the shot is charged, stemmed or fired. He will also give sufficient warning by an efficient signalling system or by other means over the entire danger zone.
- Blasting time shall be notified to staff members and surrounding village population, sufficiently in advance.
- Slope of abandoned mining pit with respect to the level of surrounding area shall be made gentle.
- Abandoned mining pit converted into water reservoir shall be fenced all around and provided with a gate and adequate security. The depth of reservoir shall be notified outside the gate for the information of visiting population. Dense plantation shall be carried out surrounding the reservoir.

Land Restoration

As seen in the case of Shaikh quarry, an unplanned quarry operation severely degrades the land. Quarry rehabilitation measures should be carried out along with quarry operations and should not be left for the end. Rehabilitation is required to:

- Put the land to some productive use such as agriculture, forestry or recreation.
- Avoid landslides.
- Maintain aesthetic beauty and avoid adverse visual impacts.
- Avoid accumulation of huge quantities of water in worked out areas.

Measures for quarry restoration is given in **Section 7.7 of Chapter 7**.

ANNEX 3.3 FOREST FIRE CONTROL PLAN REQUIREMENTS

1.0 INTRODUCTION

Fire plays an important role in many forest and range ecosystems. Fire intensity and effects vary from stand replacement conflagrations to creeping understory fires; and as a result, the challenge of managing wildland fire is complex. Forest Fires threatens thousands of acres in India. In SGNP, 71 cases of forest fires were reported in the year 1998-99 which damaged about 340.02 Ha of forest standing crop.

The destructive or beneficial effects of fire depend upon the nature of the fire and the resultant damage. Timber, wildlife, aesthetic, and recreation resources all too often are damaged due to wildfires. Following intense burning, soils and watersheds can suffer immediate and long-term damage. Buildings, historical features, and other structures also may be damaged or destroyed. In SGNP the major cause of fire is man-made, mainly by encroachers and trespassers.

1.1 PURPOSE

The purpose of this plan is to give an outline of (1) organizational practices and management policies, and (2) specify requirements on safe procedures and equipment to ensure the successful prevention and control of wildland fires. This outline can serve as a basis for developing a ***Forest Fire Management Plan*** for SGNP.

1.2 FOREST FIRE MANAGEMENT PROGRAM

The management program can be subdivided into 3 important sections – Prevention, Pre-suppression and Techniques for Fire Control. These are presented below in detail:

1.2.1 PREVENTION

Fire is an ever present danger, and, to be effective, fire prevention must be constantly practiced. Each fire prevention program should analyze the common cause of fire, identify fire hazards and risks existing in the protection area, and propose measures to reduce the threats of fire and fire damage.
The most important elements of fire prevention would be:

- ***Education of general population and members of administration***

  The main aim of fire prevention education is to create keen awareness in the public and administration/enforcers about damages caused by fires and the

necessity of fire prevention, safe ways of performing certain operations without starting forests fires etc. Some of the methods, which can be easily adopted, are:

- ➔ Training
- ➔ Signs, Posters, Displays, Exhibitions etc.
- ➔ Circulation of Printed Material
- ➔ Special programs and campaigns
- ➔ Individual and group contacts

- ***Enforcement and Compulsions***

  Enforcement of laws, regulations, rules, and restriction for fires and their communication through sign boards and warning notice boards; Rewards in connection with fire investigations; permits and fire plans etc.

- ***Creating and Maintaining Fire Lines (Fuel management)***

  Fire line construction and control burning along the firelines and forest tracts and roads and clear demarcation of forests. Creation of internal and external fire lines. Preparation of compartment boundary of 3 m width, so that fires are curtailed and do not spread easily.

- ***Fire Prevention Plans***

  In order to define a fire prevention strategy, it is imperative that determination of causes of fires and predominant locations and periods etc. be identified and researched. Based on the results, Fire Prevention Plans and Maps should be prepared and implemented.

1.2.2 PRE-SUPPRESSION PROGRAM

Pre-suppression is the function of preparing for fire suppression. As a minimum, the following activities are included:

- Training/Certification and Qualification
- Mobilization Planning
- Pre-attack Planning
- Fire Response Plan
- Incident Detection and communications
- Logistical Services
- Every Division employee who participates in fire suppression shall receive formal fire training for the task assigned.

Training Program

Every employee involved in division suppression activities should have the formal basic Forest Fire Training course as a foundation for subsequent formal fire training. This is to ensure individual's safety and incident organization effectiveness.

Mobilization Planning

Mobilization planning is preparing to respond to an incident. Forest Department should prepare and maintain current Mobilization Guides. Included in this Guide will be:

- A listing of personnel qualified to assume incident command system positions. The locations, inventories, and special instructions of all fire caches, vehicles and equipment staged for response.
- A listing of agencies and organizations with which cooperative agreements have been established.
- A directory of vendors that provide logistical support and resources.
- An itemization of department administrative matters related to fire management, i.e. organization, authorities, and administrative procedures.

Pre-Attack Planning

Pre-attack planning is a procedure to ensure appropriate and efficient suppression to a given area. Department should prepare pre-attack plan for its management units to include:

- A survey of all existing facilities, topographic features, firelines, access routes, and other items judged to be important to the successful control of the fire.
- Map of items surveyed, using a standard system, set of symbols, sign colour etc.
- Plan and propose additional facilities, fuel breaks, firelines, and other aids for fire suppression including type of maintenance required.
- Estimate the number of men, equipment, and time needed to construct planned lines, travel times, fire camp capacities, and other facts that will help make control of the fire faster and more efficient.
- Catalog of all the above physical and factual information, process, and issue in a form suitable for use by personnel in fire suppression.
- Construct and maintain new lines and facilities according to plan as funds and time permit.

- Incorporate the ideas and needs of all range resource functions into the planning.
- Update the pre-attack plan prior to fire season.

Incident Detection and Communications

Fire detection in India and in SGNP mainly consists of appointment of seasonal fire patrol whose duty is to keep watch during the fire season and inform officials of a fire occurrence and assist in fire fighting. However this staff does not have any formal training in or expertise in fire detection and fire fighting.

Use of Watchtowers: To ensure swift action against fires, it is imperative that they be detected early. Based on the fire survey results, watchtowers should be erected at critical locations prone to fire hazard. Watch towers should have the maximum unobstructed view and should provide for comfort, convenience and protection of the observer. The design should provide for safety against lightning, high winds and falling trees. The observers in the watchtower should be provided with suitable equipment to assist him in locating the fire and communicating the incident, these include:

➔ Topographical map
➔ Binoculars
➔ Communication equipment (wireless radio)

Good communications is the key to safe and efficient command and control, deployment of tactical resources, and logistical support for any incident management.

Fire Response Plan

This refers preparation of a response plan and command structure for actual fire fighting. The response plan should include the chain of command starting from actual detection of the fire incident, communication of the incident, responsibility and authority of the incident observer, incident controller and other officials in the park.

Qualified personnel should have enough personal and official gear to allow them to respond to a fire and to stay on an incident for sufficient duration. The list of necessary equipment is as follows:

- Fire Suppression Gear – Adequate handtools for fire fighting should be procured and training should be given for their use. Some equipment popular in the western countries include Axe, Hoe, Palaski Tool, Broom Rake, Shovel, Fire Broom, Mattock etc.
- Personal protection gear such as protective clothing, face masks etc.
- First Aid and Medication
- Wireless and communication equipment etc.

Logistical Services

Logistical services encompass the contracting, vending, utility, and logistical entities that assist forest department during incidents.

- Maintain an active list of key vendors and contractors by resource type.
- The vendor listing shall be maintained, and current copies forwarded to the Protection Forester for coordinated updating of the state-wide mobilization guides.
- Periodic inspections by the fire management staff to ensure that fire fighting tools, equipment, and material are always in a high state of readiness.
- The purchase of appropriate vehicles and equipment are encouraged to meet wildland fire protection needs. A systematic acquisition/replacement budget schedule should be developed based on a reasonable fire management plan for each Branch.

1.2.3 FIRE SUPPRESSION

The objective of the fire suppression program is to fight fire aggressively with full consideration for employee safety, potential loss of life and property, and resource values threatened. We are yet very far from using superior fire fighting techniques and support used in western countries such as use of dedicated, organized and well trained fire gangs, fire extinguishing using various methods from aircraft or helicopter etc. However, we should at a minimum train our current man-power and equip them with the latest fire fighting tools to maximize fire fighting efforts.

Efficiency could also be maximized by:

- Organizing and staffing to meet suppression objectives
- Utilization of mutual aid assistance to meet suppression objectives.
- Implementation of mobilization procedures that respond within reasonable times to incident needs.
- Development of reasonable control objectives with due consideration for public safety, structural protection, and resource values threatened.

Fire Response

The fire fighting mechanism is to be initiated as per the Fire Response Plan. The Incident Commander is responsible for the tactical deployment and logistical support for all firefighting resources.

The Incident Commander will make regular analysis of the fire situation and will adjust his strategy and tactics accordingly to meet the fire suppression goal. In large fire scenarios that exceed the divisions ability to successfully extinguish fires,

the Incident Commander through the Dy. Conservator or his designate will request additional assistance from statewide resources. The kinds of assistance requested will be specifically listed. At a minimum, it shall include: type and number of resources, and other coordinating instructions, such as when and where to send.

Demobilization

Demobilization of all activated resources for fire fighting is a very important task. The Incident Commander and his staff will prepare a demobilization plan which should include:

- A plan of action for the systematic release of workers and equipment.
- The orderly and sequential shutting down of all operations.
- Fire Reports. All incident related documentation shall be as concise and timely as possible, i.e. completion of all fire-related reports within ten (10) days of fire extinguishment.
- Repair and maintenance of all equipment used on the incident.
- Replacement of items rendered unserviceable or expended.
- Debriefing and/or critique will be conducted before the incident management team demobilizes.

ANNEX 3.4(A) Monitoring Parameters, Frequency and Locations

No.	Environmental Components	Parameters	Location	Frequency	Remarks
1	**Surface Water**	Dissolved oxygen. Total nitrogen and phosphates, chlorophyll 'a', pH, Coliforms, *E.coli*	**Tulsi Lake** 1. Near dam 2. Intake well [Refer Annex 2.8 (a)] **Vihar lake** 1. Near darga 2. Intake well 3. Opp. Bhandup Complex [Refer Annex 2.8 (b)]	Once a year (Preferably in Summer Season)	Values to be recorded and maintained. Values given in Chapter 4, represent baseline values monitored in the Year 2000 and can be used for comparison.
		Electrical conductivity, TDS, alkalinity, pH, Coliforms, *E.coli* , BOD	**Dahisar River** 1. Outlet of the river at forest boundary 2. Dahisar river inside core forest	Once in a year	------do-------
		Oil and grease, Dissolved oxygen, BOD.	**Bassein Creek (near forest boundary)**	Once in a year	------do---------
2.	**Ground Water**	TDS, pH, conductivity, alkalinity, manganese, iron, coliforms	1. Borewell Near Tumnipada 2. Yeur village borewell	Once in a year	-------do--------

Annex 3.4Cont.

No.	Environmental Components	Parameters	Location	Frequency	Remarks
3.	Air quality	SPM, NOx, SO_2, CO	1. Tulsi lake 2. SGNP Borivali Gate 3. Kandivali boundary 4. Yeur Village	Once a year, preferably in winter season (24 hrs. average)	Values to be recorded and maintained. Values given in Chapter 4, represent baseline values monitored in the Year 2000 and can be used for comparison.
4.	Noise	--	1. Tulsi lake 2. SGNP Borivali Gate 3. Kandivali boundary 4. Yeur village	Once in a year (Hourly reading for one day)	-----do------
5.	Vegetation	Height, Canopy Cover, Species Frequency, Density, Dominance, Importance Value Index and Community coefficient.	1. Tulsi log hut area 2. Vihar (Mori No. 19) 3. Sasunavghar-Compartment no. 1115 4. Kandivali –Gautam Nagar 5. Yeur (West) Compartment No. 1141 6. Chenna (east) – S.No. 89 Same locations as for baseline studies.	Once in Two years	-----do------
6.	Landuse Study	Forest cover, mangroves, waterbodies, aquatic and shoreline vegetation, human settlements and encroachments etc.- using satellite imagery	SGNP Division	Once in three years	------do------

Annex 3.4 (B) Parameters for Monitoring under Bio – monitoring Program

No.	Component	Parameters	Frequency	Locations	Remarks
1.	Air quality	Dust Deposition on : 1.*Ficus bengalensis* 2. *Thespesia populnea* 3. *Macranga pelpata*	October, January and April	• Mahindra end (Kandivali) • Vihar Catchment • Tulsi catchment near log hut	Thickness of dust layer indicates degree of dust load in air. Proforma for recording results is given in **Annex 3.5(C).**
2.	Forest Degradation Indicators	Indications of disturbances like fire, grazing etc.	September, December	Vegetation mapping locations selected for this study (same locations as given in Annex 3.4(A) for vegetation component) or can be selected by forest department depending upon the need of monitoring of particular area	▪ Presence of Phungla stands (Pogostemon parviflorus) – indication of fire in recent past ▪ Presence of Neel, Sharpankhi (Indigofera, Tephrosia) indication of intensive grazing ▪ Presence of Ghaneri (Lantana weed), Eupatorium – indication of disturbance ▪ Presence of grassy stretches – indication of forest degradation of serious nature ▪ Presence of scattered shrubs and stunted trees – indication of degradation and cutting of wood
		• Tree Canopy • Canopy Cover	Once in a season	---do---	▪ Proforma for recording results is given in **Annex 3.5(C).**
3.	Soil erosion	Colour	October (post monsoon), April-May (pre-monsoon)	-----do----	▪ Darker soil-better nutritive and water holding value, light yellow colour – poor fertility status) ▪ Proforma for recording results is given in **Annex 3.5(C).**
		Silt deposition	End of rainy season		▪ Gravel ratio – High gravel – high erosion, High silt – high sediment deposition, i.e. high erosion in catchment

No.	Component	Parameters	Frequency	Locations	Remarks
		Bio-monitors Observation of plant communities / stands			▪ Presence of castor, spiny amaranth – nitrification of soil – indicating decomposition of organic matter in excess proportion (e.g. sewage) ▪ Presence of Alternanthera, Euphorbia hirta (Dudhi) with red stems – calcification of soil – excess rubble present on soil
		Thickness of soil layer above rock			▪ Thin layer indicates high erosion
		Water turbidity		1. Tulsi near log hut 2. Vihar	▪ Indication of erosion on slopes of catchment. ▪ Proforma for this is given in tables below

Annex 3.4(c) Proforma for Recording Results of Bio-Monitoring in Forest Area

1) AIR QUALITY

Date:- **Team of observers: 1.**
Site:- **2.**

No.	Tree species	Observation				Remark
*	*Ficus bengalensis*	Heavy	Medium	Low	None	Possible source (Traffic on road)
1.		+	-	-	-	
2.		+	-	-	-	
3.		-	+	-	-	
*	*Thespesia populnea*					
1.		-	+	-	-	Stone crusher
2.		-	-	+	-	
3.		-	+	-	-	
*	*Macranga pelpata*					
1.		-	-	-	+	
2.		-	-	-	+	
3.		-	-	-	+	

2) WATER QUALITY –

Date:- **Team of observers: 1.**_____

Site:- **2.**_____

a) Parameter - Turbidity

Method used: Secchi disc visibility / visual

No.	Place	Observation	
1.	1 m from the bank	Code	Meaning
2.	10 m from the bank with the help of boat	1	Very turbid
		2	Turbid
		3	Semi- transparent
		4	Crystal clear

Very turbid – Disc colours distinct upto 2-cm depth only
Turbid – Disc colours distinct upto 15-cm depth only.
Semi transparent – Disc colours distinct upto 100 cm depth
Crystal clear – Disc colours distinct beyond 100-cm depth

b) Parameter – Colour

Colourless – Clear
Bluish - Clear
Brownish – Polluted (organics / chemical)
Greenish – Phytoplankton or weed rich

3) SOIL QUALITY

Date: Site Observers – 1.
Site: 2.

General – Level ground / steep slope / gradual slope / bottom of slope / top of slope

Parameter	**Observation**	**Remarks**
Colour	Yellowish Reddish Deep Grey	Poor quality Poor Rich
Thickness	Thin / medium/ thick	Eroded/medium / conserved
Texture	Gravely Sandy Silty	Eroded Eroded Sedimented

4) PLANT COMMUNITY

Date: Site Observers: 1._____
Site: 2._____

Parameter	Observation	Remark
Tree Canopy	High Low Shrubby	Healthy Disturbed Degraded
Canopy cover	More than 60 % Between 20 –60 % Less than 20% Grassy	Good forest Disturbed Degraded Highly degraded

ANNEX 3.5 Summary of the Proposed ZONAL Programs in the Draft Forest Management Plan

Name of Zone	Proposed Programs
A) Core Zone Development *Objectives : To provide complete protection, To improve wildlife habitat*	**Prey base enrichment** • Provide strict protection against any biotic interference • 200 herbivores preys (Sambar/ Chital) will be released in a phased manner during planned period, which will compensate the prey shortage for panthers. • These herbivores will be kept in an enclosure of 1-hectare area fenced with chainlinks. Grass and suitable fodder plantation will be done in the enclosure one-year before release. • No visitors will be allowed.
	Grassland Development • Four small areas have been selected for creating grasslands. • In such areas bush cutting will be done so as to allow grass to grow
	Mangrove Conservation measures • Survey of mangrove areas and boundary demarcation will be made to indicate external boundaries adjoining private areas and low tide line (LTL). • Identification of mangrove flora and area estimation. • Mangrove nursery will be raised and priority will be for endangered and locally extinct species. • Facility of watch towers to study faunal species. • Control of pollutants – e.g. plastic bags, etc.
	Edge Enhancement • Borivali – Bhandup Road will be available only for government vehicles. • Proper solid waste management
B) Conservation Developmental Zone	• Nature Interpretation centre • Nature information centre
C) Eco- restoration zone *Objectives: Ecological restoration of the affected areas and to remove encroachments.*	**Encroachment Removal** • As per the High Court's order and their year of settlement; encroachments would be removed. • Constructions of boundary wall to prevent further encroachments on sensitive boundaries.

Annex 3.5Cont..

Name of Zone	Proposed Programs
	Settlement of Disputes • Quarry inside reserved forest land
	Improvement of Degraded forests • Plantation will be done depending upon slope and soil on 300 ha. area of land mostly on external boundaries
D) Multipurpose Use Zone	**Population estimation of wild animals** • Panthers – Pugmarks and camera track will be employed • Herbivores • Birds – Arboreal and wetland birds
	Illicit Tree Felling and protection • In order to check illicit felling and other protection a new mobile squad will be created with its head-quarter at Thane (1 RFO, 1 Forester, 1 police constable) • Roads upgradation • Weapons for staff protection • Construction of new chechnakas • Use of motor boat for protection work
	Communication System • All roads and culverts will be properly maintained.
	Fire Protection • Fire tracing • Patrolling too control the entry of people in prohibited area • Public awareness • Sensitive beat guards will be provided 2 fire watchers each for fire fighting works from Feb. 15 to June 15 in each year • To purchase modern forest fighting tools • Training to the staff
	Survey and demarcation • Prescription for survey, boundary demarcation and maintenance of boundaries will be applicable throughout the division except for Eco- restoration zone for which special scheme for boundary demarcation has been prescribed. • Boundary maintenance

Annex 3.5Cont..

Name of Zone	Proposed Programs
	Soil and moisture conservation • SGNP is divided in 5 moisture cum soil conservation series. • The work mainly includes Gully plugging, check dams, nalla bunding depending upon the status of soil erosion.
	Legal Strengthening In order to provide adequate legal protection to all the areas – • All unclassed forests, protected forests and reserved forests not included in SGNP will be declared as Krishnagiri wildlife sanctuary. • The disputed areas will be settled on top priority.
	Extension of SGNP • Dy. Conservator of forest, SGNP division will prepare a proposal to bring additional areas (116 sq.km.) of Thane forest div. Under the wildlife management of this division.
	Man – Animal conflict To reduce man – animal conflict following steps will be taken – • Exhibits will be displayed at suitable place for caution from wild animals. • Patrolling team of about 5 persons will move in such areas during night. • A panther will be trapped only when it becomes dangerous for the people. • The compensation for the loss of lives of cattle/ human beings will be paid according to the Government order in force.

ANNEX 4A

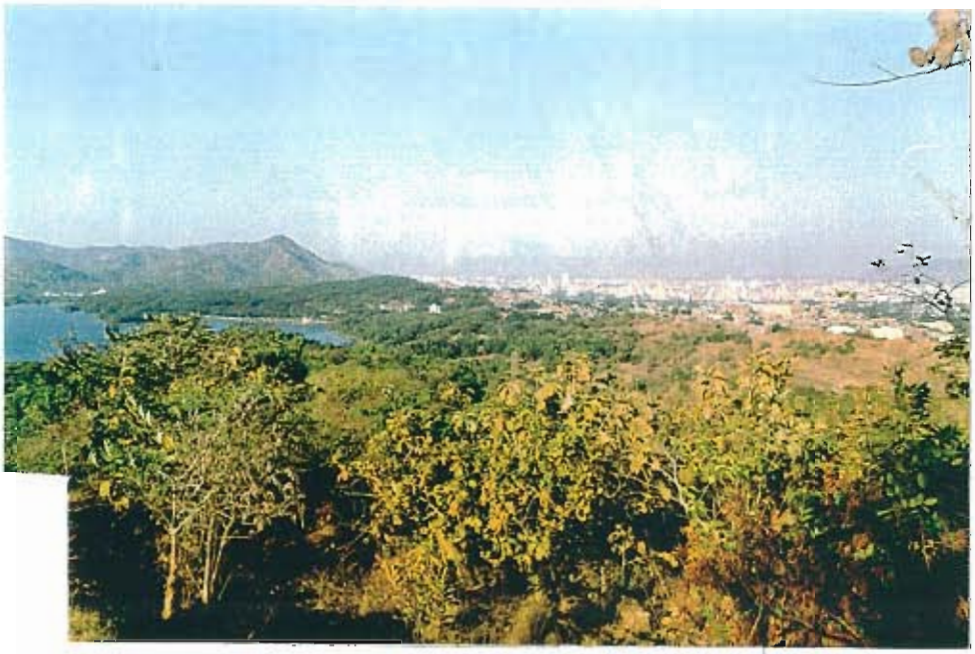
PARK PHOTOGRAPHS

1. View of the Forest from the top of Kanheri Caves

2. Bhendi Stream in Yeur Range

3. Dahisar Stream Flowing through Dense Forest of KUP Range

4. View of Tulsi Lake Catchment



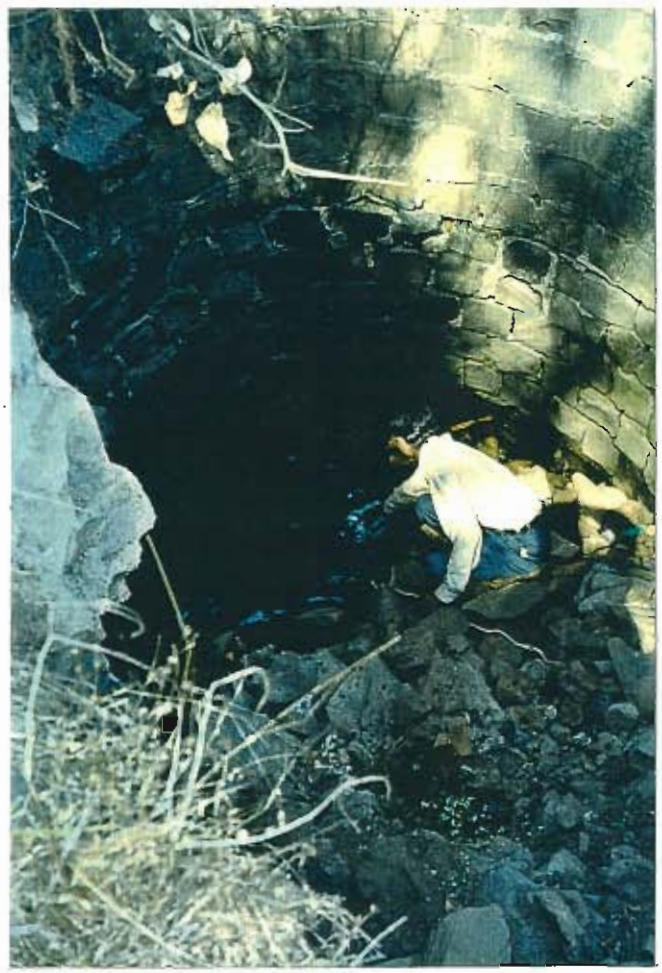
5. View of Vihar lake Catchment

6. View of Powai lake Catchment

7. Kanheri Caves

8. Interpretation Centre at Manpada

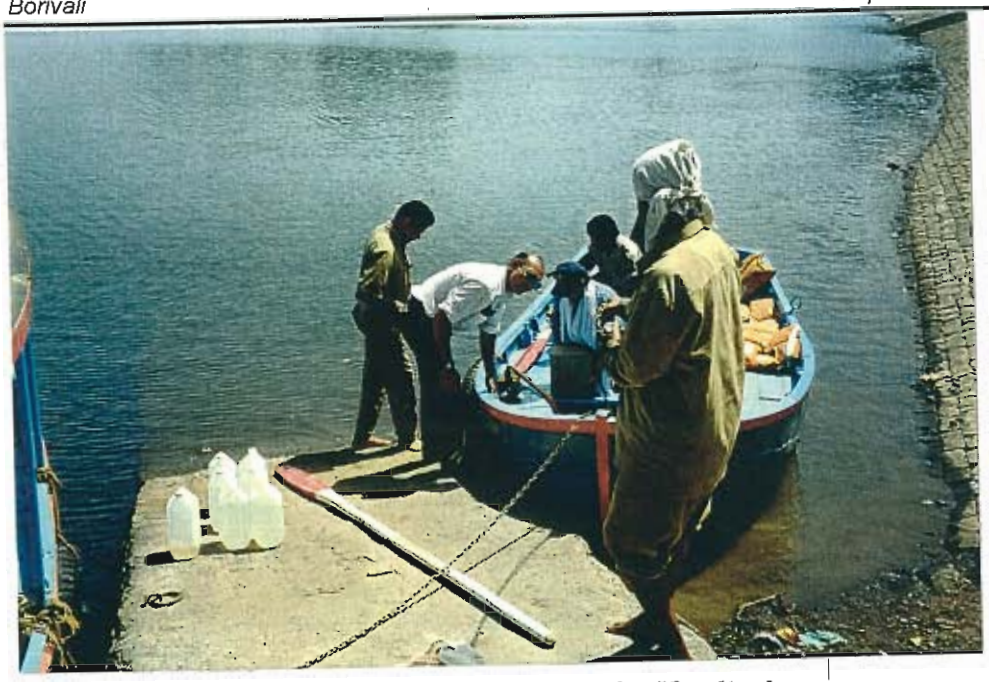
9. Air sampling at Yeur Village



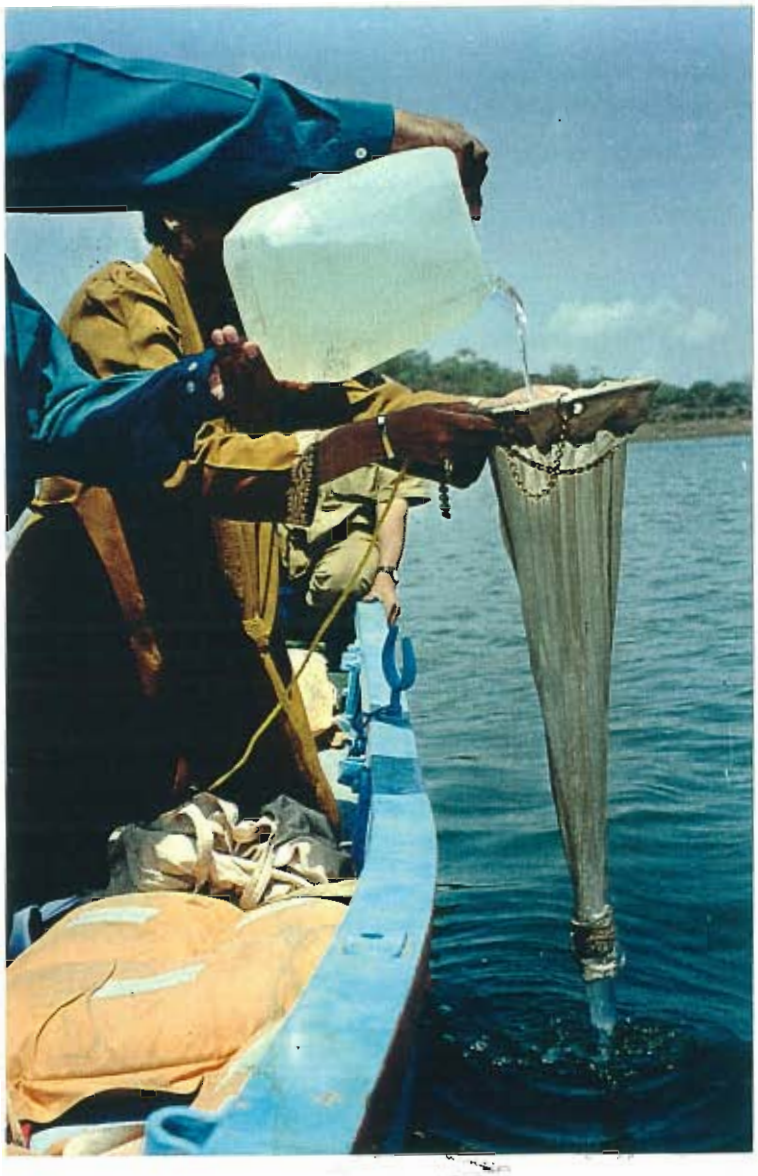
10. Open Well Water Sampling at Yeur Village

11. Macrophyte assessment on the Bank of Vehar Lake

12. Physical Survey for Macro- invertebrates Assessment



13. Team Preparing to Go for Lake Monitoring



14. Lake Water Sampling for Plankton Assessment

15. Vegetation Mapping Exercise at Tulsi Shore line

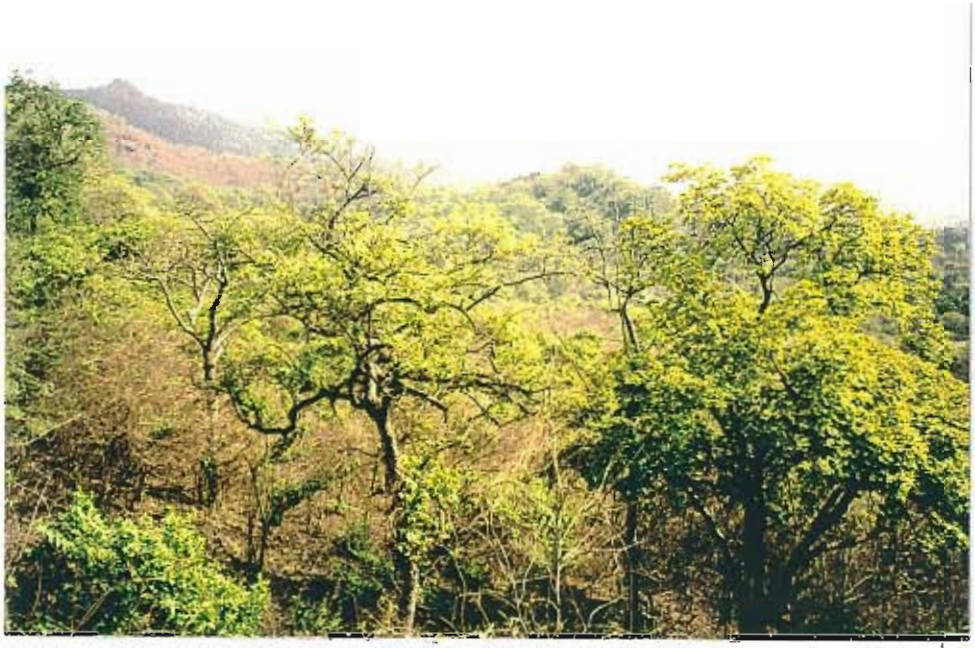
16. Vegetation Mapping in Progress

17. Tulsi Forest – Dense Vegetation Growth In Two Storeys (Medium Sized trees and bushes)

18. Tulsi lake – Hill slopes covered by dense vegetation

19. Yeur Forest – Deciduous Nature of visible prominently

20. High Dense Yeur Forest



21. View of the Hills with Dense Cover of Chenna Forest

22. View of the Chenna Forest

23. Agricultural Fields in Nagla Block

24. Our Team with Forest Officials – Surveying the Problem Areas in SGNP Range, background is Powai Lake

25. Mini Train in non operating condition

26. Deer Park in Tourism Zone - needs considerable improvement

27. Children Park in Tourism Zone which needs renovation and some extra attractions for children

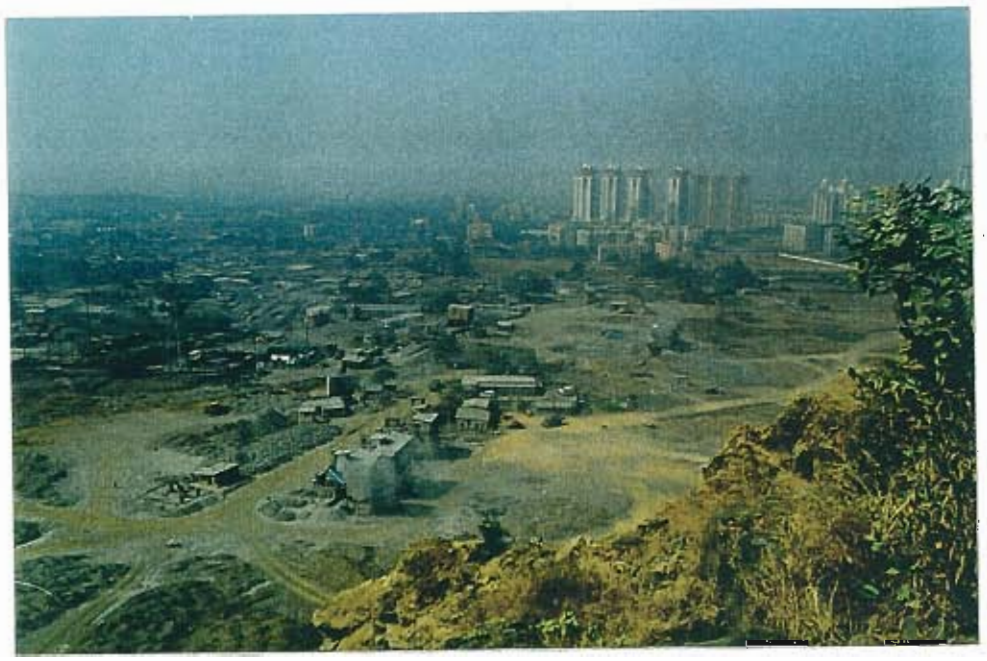
28. Degraded Land Around Mafco Factory

29. Contaminated water body surrounded by degraded area of Mafco factory

30. On land disposal of solid waste from Mafco factory

31. Solid Waste Littered Near Forest Quarters, background is the human settlement

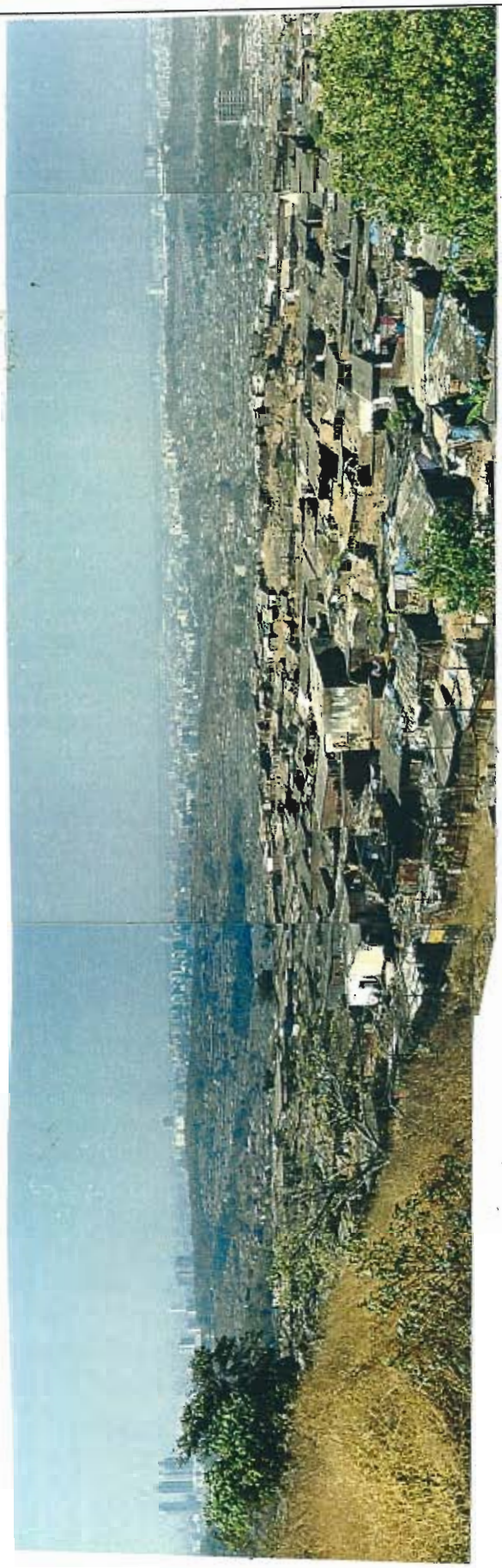
32. Cracks Observed Due to Quarry Operations Near Malad Forest Boundary



33. Quarry Operating Near Malad Forest Boundary

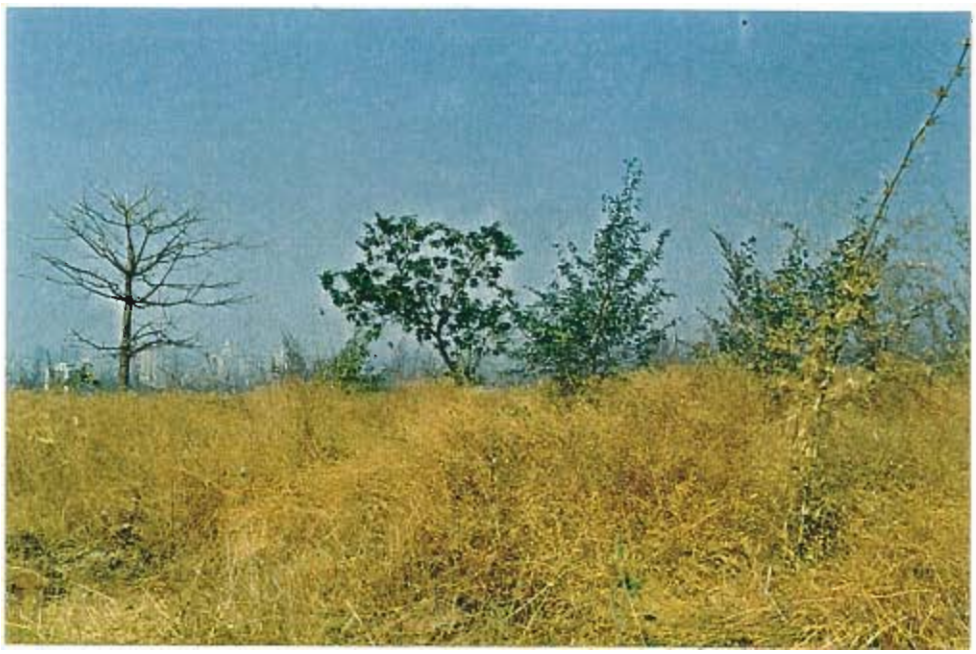
34. Quarry Operating on the Park Boundary at Dahisar

35. Waterholes Created for Wild animals in old Shaikh Quarry Area



36. Encroachment Near Malad – Kandivali Boundary - Before Demolition

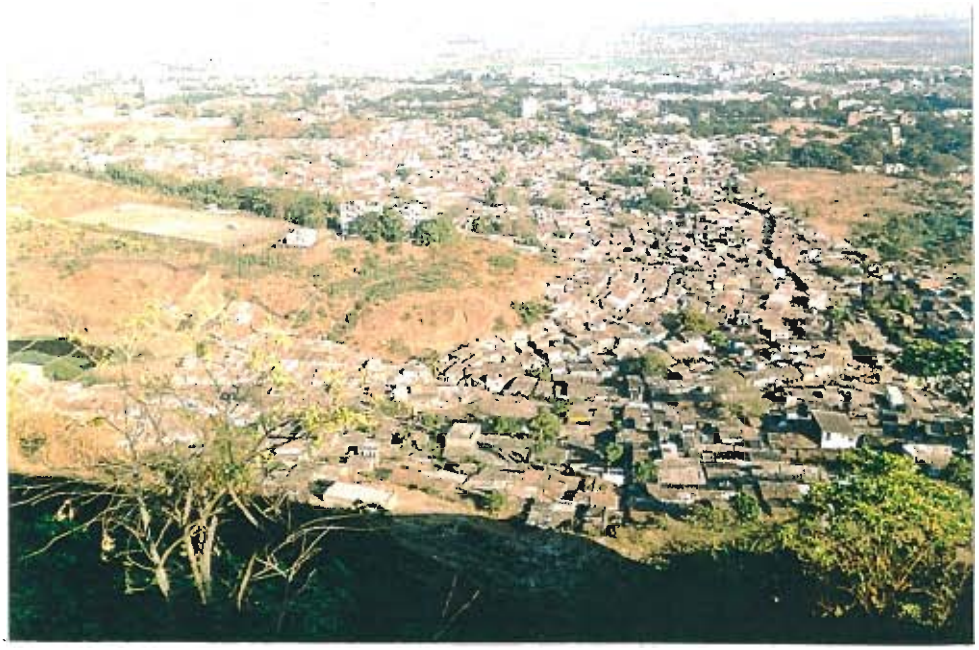
37. Plantation – Mulund Beat of SGNP range



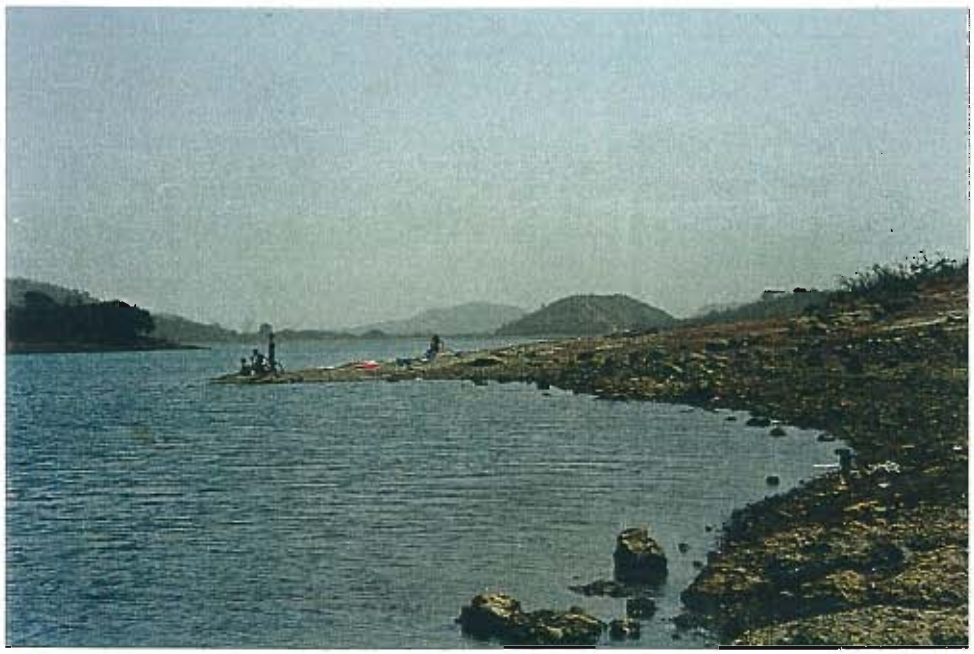
38. Plantation On Malad Side Forest Land – After Demolition

39. Forest Fire Patch

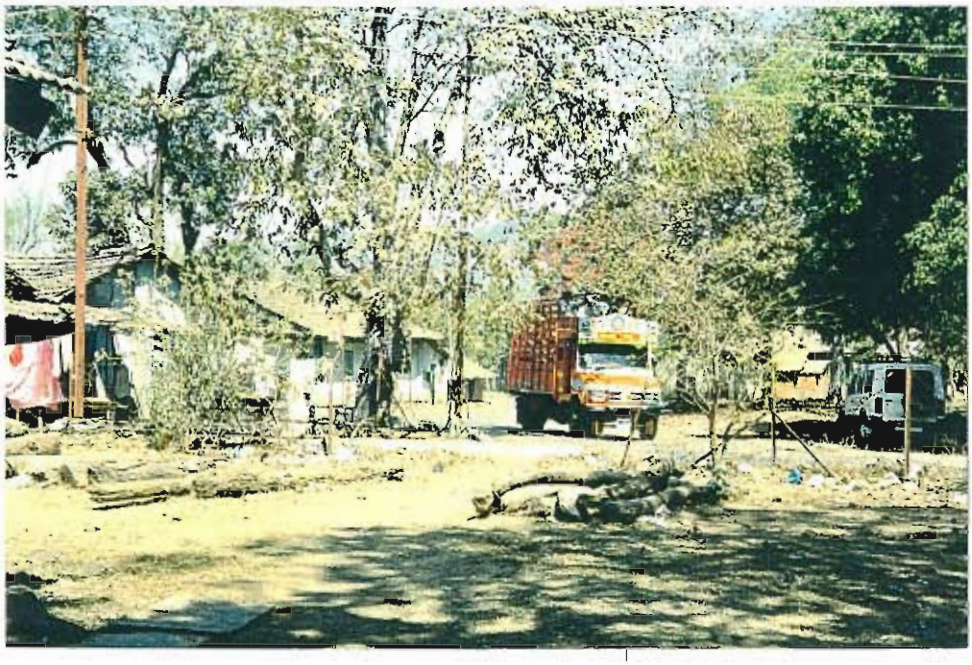
40. Teak Bark Infected with Termite



41. Phule Nagar Seen from Hanuman Hill (located on fringe of Vihar Catchment, outside SGNP)



42. Human activities on Vihar Shoreline



43. Yeur Village

ANNEX 4(B)

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