Rashtriya Chemicals and Fertilizers Limited
(Government of India Undertaking)

राष्ट्रीय केमिकल्स एण्ड फर्टिलाइजर्स लिमिटेड
(भारत सरकार का उपक्रम)

साथ बढ़ें समृद्धि की ओर

पंजीकृत कार्यालय : "प्रियदर्शनी", ईस्टर्न एक्सप्रेस हाइवे, मुंबई - 400 022.
REGD. OFFICE : 'PRIYADARSHINI', EASTERN EXPRESS HIGHWAY, MUMBAI - 400 022.
वेबसाईट / Website : www.rcfltd.com • CIN No. : L24110MH1978GOI020185

RCF/Tr/ENV/ Nano Urea /2025-26

22nd Apr2026

To,
Additional Principal Chief Conservator of Forests
Ministry of Environment, Forests & Climate Change
Regional Office (West Central Zone)
Ground Floor, East Wing,
"New Secretary Building" Civil lines,
Nagpur-440 001

Sub.: Submission of compliance report of "Installation of New Nano-Urea Fertilizer Plant" of total capacity 27,375 KL/annum at Trombay unit, Mumbai (Maharashtra)-

Ref.: MOEF&CC memorandum File No. Proposal No. IA/MH/IND3/426519/2023; File No. IA-J-11011/216/2021-IA-II(I)] dated 29.05.2023

Dear Sir,

With reference to your above mentioned letter we are sending compliance report of "Installation of New Nano Urea Fertilizer Plant" of total capacity 27,375 KL/Annum at R.C.F. Trombay Unit, Chembur, for the period of Oct- 25 to Mar-26 for your kind perusal.

Thanking you,

Yours Sincerely,

संजीव हरळीकर

Sanjeev Haralikar
Executive Director (Trombay)I/c.

VBK

Compliance report on proposed project of "Installation of New Nano-Urea Fertilizer Plant" of total capacity 27,375 KL/annum located at RCF Trombay Unit. [MOEF&CC memorandum File No. Proposal No. IA/MH/IND3/426519/2023; File No. IA-J-11011/216/2021-IA-II(I)] dated 29.05.2023

A. Compliance of the terms and Conditions mentioned in point 22:

S. N.	Conditions	Compliance Status
i)	The PP shall develop Greenbelt over an area of atleast, 57.93Ha (34.43 Ha in Trombay unit & 23.5 Ha in RCF Trombay Township) by planting 33306 within a period of one year of grant of EC. The saplings selected for the plantation should be of sufficient height, preferably 6-ft (about 2 m). The budget earmarked for the plantation shall be kept in separate account and should be audited annually. PP should annually submit the audited statement along with proof of activities viz. photographs (before & after with geo-location date & time), details of the expert agency engaged, details of species planted, number of species planted, survival rate, density of plantation etc. to the Regional Office of MoEF&CC before 1st July of every year for the activities carried out during the previous year.	The RCF Trombay Unit conducted a study titled *"Assessment of Green Belt and Upgradation Plan including Restoration Plan at RCF Trombay Unit, Chembur"* through M/s Terracon Ecotech Pvt. Ltd. The consultancy has valid accreditation as a Category-A (SA4) organization under the QCI – NABET scheme for Environmental Impact Assessment (EIA) consultant organizations (Version 3), for the period from March 2023 to October 2023. As per the study report RCF Trombay unit covered a total green coverage area of 62.20 %. The detailed study report is attached as Annexure-1.
ii)	A separate Environmental Management Cell (having qualified persons with Environmental Science/Environmental Engineering/specialization in the project area) equipped with full-fledged laboratory facilities shall be set up to carry out the Environmental Management and Monitoring functions. PP shall engage executive director- dy. general manager (HSE)- Assistant general manager chem (Env)-chief manager (chem) Env- Engineer chem (Env). In addition to this one safety & health officer as per the qualification given in Factories Act 1948 shall be engaged within a month of grant of EC. PP should annually submit the	The RCF Trombay unit has Separate Environmental Management Cell comprising Chief Manager (Chem), Dy. Manager (Chem) and Sr. Environmental Engineer headed by Deputy General Manager. RCF Trombay unit is equipped with full-fledged Central Chemical Laboratory (NABL Certified) to carry out the Environmental Management and Monitoring functions. RCFL also have a fully functional Safety dept. compiling all required statutory needs in accordance to Factories Act 1948. The safety department consists of DGM(HSE), AGM(F&S), Five number of Safety officers and one electrical safety officer.

iii)	The company shall comply with all the environmental protection measures and safeguards proposed in the documents submitted to the Ministry. All the recommendations made in the EIA/EMP in respect of environmental management, and risk mitigation measures relating to the project shall be implemented. The budget propose under EMP is ₹ 129 Lakh (Capital cost) and ₹ 54.12 Lakhs /annum (Recurring cost) shall be kept in separate account and should be audited annually. The PP should submit the annual audited statement along with proof of implementation of activities proposed under EMP duly supported by photographs (before & after with geo-location date & time) and other document as applicable to the Regional Office of MoEF&CC before 1st July of every year for the activities carried out during previous year.	Complied with
iv)	The total water requirement for the proposed project shall be 90 KLD Out of 90 KLD. 5 KLD freshwater shall be provided by BMC for drinking purposes. The PP should ensure that water supply should not be above the permissible limit as mentioned in the letter and fresh water shall be withdrawn only after obtaining valid agreement from Concerned Authority. The PP should submit the details of utilization to the Integrated Regional Office (IRO), MoEF&CC before 1st July of every year for the activities carried out during the previous year.	Complied with
v)	The wastewater generation shall not exceed 9.25 KLD (sewage: 4 KLD, Industrial Effluent 5.25 KLD), Sewage shall be treated in STP & reused for horticultural purposes while Industrial effluent shall be treated in ETP & reused in gardening purposes. The plant shall achieve ZLD.	Complied with
vi)	No banned chemicals shall be manufactured by the project proponent. No banned raw materials shall be used in the unit. The project proponent shall adhere to the notifications/guidelines of the Government in this regard.	Compliance assured.

vii)	The project proponent shall comply with the environment norms for fertilizer Industry as notified by the Ministry of Environment, Forest and Climate Change, *vide* GSR 1607(E), dated 29.12.2017 under the provisions of the Environment (Protection) Rules, 1986.	Yes, RCF Trombay unit is complying all environment norms for fertilizer Industry as notified by the Ministry of Environment, Forest and Climate Change, vide GSR 1607(E), dated 29.12.2017 under the provisions of the Environment (Protection) Rules, 1986.
viii)	The species-specific conservation plan of Schedule-I species shall be implemented within time limit and as per the approval of the Chief Wildlife Warden of the State Government.	RCF has submitted the species-specific conservation plan of Schedule-I species for approval of Chief Wildlife Warden (CWW), Nagpur through Additional Principal Chief Conservator of Forest (APCCF), Maharashtra State. Approval of the conservation plan is received on 07.07.2025. RCF has conducted 1st awareness programs on monitor lizard on 27.10.2025 (Copy of post about the program on RCF Kisan Manch X handle is attached). RCF has also installed sign boards for "Endanger Species Habitat" in our factory area. 
ix)	The project proponent shall utilize modern technologies for capturing of carbon emitted and shall also develop carbon sink/carbon sequestration resources capable of capturing	As the process does not involve combustion or gas-generating reactions, the Nano Urea Plant will not contribute for capturing of carbon

	more than emitted. The implementation report shall be submitted to the IRO, MoEF&CC in this regard.	emitted. Accordingly, no gaseous emissions are involved in the plant operations.
x)	All necessary precautions shall be taken to avoid accidents and action plan shall be implemented for avoiding accidents. The project proponent shall implement the onsite/offsite emergency plan/mock drill etc. and mitigation measures as prescribed under the rules and guidelines issued in the Manufacture, Storage and Import of Hazardous Chemicals (MSIHC) Rules, 1989, as amended time to time, and the Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996.	RCFL has onsite/ offsite emergency plan (ECP-Emergency Control Plan) as per statutory requirement and had submitted the document to the respective authorities. Regular mock drills are being conducted to check emergency preparedness and handling. The Emergency Control Plan will be revised for inclusion of Nano-urea plant activities.
xi)	The volatile organic compounds (VOCs)/Fugitive emissions shall be controlled at 99.97 % with effective chillers/modern technology. Regular monitoring of VOCs shall be carried out.	No generation of volatile organic compounds (VOCs) during Nano Urea production. However, regular monitoring of VOCs is being carried out by MoEFCC approved third party laboratory.
xii)	The storage of toxic/hazardous raw material shall be bare minimum with respect to quantity and inventory. Quantity and days of storage shall be submitted to the Regional Office of Ministry and SPCB along with the compliance report.	Compliance assured.
xiii)	The occupational health centre for surveillance of the worker's health shall be set up. The health data shall be used in deploying the duties of the workers. All workers & employees shall be provided with required safety kits/mask for personal protection.	RCFL have fully functional Occupational Health Centre (OHC) with ambulance, qualified doctor and nurse. RCFL also have its own Hospital in company township which is approx. 1 KM away from factory.
xiv)	Training shall be imparted to all employees on safety and health aspects for handling chemicals. Safety and visual reality training shall be provided to employees. Action plan for mitigation measures shall be properly implemented based on the safety and risk assessment studies.	Safety training is a continuous process in RCFL, all plant employees, contractor employees, Tanker drivers & helpers etc. were given safety training in a periodic manner on safety and health aspects for handling chemicals. Safety and visual reality training shall be imparted to employees of Nano Urea plant on their deployment.

		RCFL has established ISO 45001, PSM & HSE index systems and continuously maintaining the same. Based on the safety and risk assessment studies of Nano Urea plant, action plan for mitigation measures shall be developed and implemented.
xv)	The unit shall make the arrangement for protection of possible fire hazards during manufacturing process in material handling. Fire-fighting system shall be as per the norms.	Firefighting system for Nano Urea plant is developed & established as per the norms and plant design requirement in coordination with project department. In Trombay unit factory premises, set up of full fledge Firefighting system with fire engines & other equipments/accessories and trained fire personnel is available round the clock. Mock drills are being conducted regularly.
xvi)	The solvent management shall be carried out as follows: (a) Reactor shall be connected to chilled brine condenser system. (b) Reactor and solvent handling pump shall have mechanical seals to prevent leakages. (c) Solvents shall be stored in a separate space specified with all safety measures. (d) Proper earthing shall be provided in all the electrical equipment wherever solvent handling is done. (e) Entire plant shall be flame proof. The solvent storage tanks shall be provided with breather valve to prevent losses. (f) All the solvent storage tanks shall be connected with vent condensers with chilled brine circulation.	Not Applicable since No organic or hazardous solvents are used in the Nano Urea manufacturing process.
xvii)	The PP shall undertake waste minimization measures as below (a) Metering and control of quantities of active ingredients to minimize waste; (b) Reuse of by-products from the process as raw materials or as raw material substitutes in other processes. (c) Use of automated filling to minimize spillage. (d) Use of Close Feed system into batch reactors. (e) Venting equipment through vapor recovery system. (f) Use of high pressure-hoses for equipment cleaning to reduce wastewater generation.	(a) Production process of Nano- Urea Fertiliser is simple, and reaction takes place at atmospheric condition without generation of any liquid effluent Accordingly, it is ensured that waste generation is negligible and we have installed flow meter at ETP pump discharge and effluent is transferred to the existing centralised Effluent Treatment Plant of RCF and treated effluent water is being reused for gardening and washing purposes to maximum extent Existing

		.ETP has capacity to treat the wastewater generated in Nano Urea Fertilizer Plant. (b) No by-products in the process (c) Complied with . (d)Manufacturing process is equipped with close feed system. (e) No generation of vapours and not applicable vapour recovery system. (f) High pressure Spray ball & Silicon Hose has been installed for equipment cleaning in order to reduce wastewater generation.
xviii)	The activities and the action plan proposed by the project proponent to address the issues raised during the public hearing as well as the related socio-economic issues in the study area shall be completed as per the schedule presented before the Committee and as described in the EIA report in letter and spirit.	Compliance assured

Assessment of Green Belt and Upgradation Plan Including Restoration Plan at Rashtriya Chemicals and Fertilizers Limited (RCFL), Chembur

Final Report

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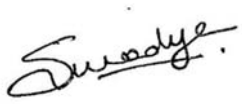
Assessment of Green Belt and Upgradation Plan Including Restoration Plan at RCFL, Chembur

Final Report

WORK ORDER REF. NO. – CC/CES/A-07/3710/L/2223/731, DATE: 04/03/2023

PREPARED FOR:
RASHTRIYA CHEMICALS AND FERTILIZERS LIMITED (RCFL), Chembur

PREPARED BY:
TERRACON ECOTECH PRIVATE LIMITED (TEPL)



NAME: SAURABH D. WADYE
DESIGNATION: ANALYST - BIODIVERSITY
PROJECT ROLE: FIELD CO-ORDINATOR

Synopsis

Project Name

Assessment of Green Belt and Upgradation Plan Including Restoration Plan At Rashtriya Chemicals and Fertilizers Limited (RCFL), Chembur

Study Area

The Rashtriya Chemicals and Fertilizers Limited (RCFL), has two operating units, one at Trombay in Mumbai and the other at Thal, Raigad district, about 100km from Mumbai. The Trombay unit is situated in central Mumbai and is surrounded by the neighborhoods of Kurla, Mankhurd, Wadala, BKC, Trombay, Govandi, Chunabhatti, Vidyavihar and Ghatkopar. About the Trombay unit, it consists of three parts: the plant area, the admin area, and the residential colonies, each of which has an area of 212 ha, 10 ha, and 60 ha.

A greenbelt assessment in the industry refers to an evaluation of the surrounding natural environment, open spaces, and potential green areas within or around industrial facilities or developments.

The study confirmed that the total carbon sequestration potential till date in the study area is 7,695 tonnes through the greenbelt area.

Importance of Greenbelt Assessment in Industry:

1. Environmental Conservation:
2. Air Quality and Climate Mitigation:
3. Water Management:
4. Sustainable Development:
5. Social Well-being:

Carbon sequestration

Carbon sequestration is the process by which atmospheric carbon dioxide is taken up by trees, grasses, and other plants through photosynthesis and stored as carbon in biomass (trunks, branches, foliage, and roots).
This is done by utilizing GIS and remote sensing technologies. Green cover can be mapped using either remotely sensed data obtained from satellite digitization of green areas using GIS software like ArcGIS, ERDAS, QGIS, etc. The satellite data in form of multispectral imagery consist of data obtained on different wavelengths in an electromagnetic spectrum. These data can be used to calculate vegetation indices for obtaining the amount of green cover.

Assessment of Greenbelt

A. Quantitative assessment of percentage green cover using GIS techniques

1. Procurement of the recent high-resolution satellite imagery

- *Satellite imagery map and details* `

For the calculation of MSAVI-2, Airbus satellite imagery *i.e.,* Pleiades P1 was procured. Worldview-3 product has a spatial resolution of 0.5m. It was licensed by Airbus Defence and Space. A tool called “indices” from ERDAS software was used to carry out supervised classification.

Note: Satellite imagery is also submitted in Pen drive.

2. Calculation of the proportion of Green Cover of the Study Area using GIS tools

Sr. No.	Study Area	Total Plot Area in Ha	Green Cover Area in Ha	Percentage
1	Admin	11	9	84%
2	Colony	69	57.1	83%
3	Plant	204	110	54%
	Total	**283**	**176**	**62.20%**

3. Calculation of the proportion of Tree Cover/Greenbelt of the Study Area using GIS tool

Sr. No.	Study Area	Total Plot Area in Ha	Tree Cover Area in Ha	Percentage
1	Admin	11	7.1	66%
2	Colony	69	53	77%
3	Plant	204	53	26%
	Total	**283**	112	**39.69%**

B. Qualitative assessment - vegetation study of existing green belt

1. Study of existing and previous green belt/vegetation including tree count and identification of the tree species (Plot Count)

Sr. No.	Study Area	Total Area in Ha	Tree cover area in Ha	Total tree count
1	Admin	11	7.1	8411
2	Colony	69	53	64779
3	Plant	204	53	51482
Total		**283**	**112**	**124672**

2. Provide ecological insight in terms of diversity map, phytosociological studies, rare species, endemism, and seasonality

- *IUCN Red List*

2.1 Species density

Tree species density refers to the number of different species of trees within a specific area or ecosystem.

2.2 Phytosociological studies

- Aesthetically and Economically Important tree species
- *Important trees in the context of air quality and dust-prevention*

3. Calculating the Native to Exotic Ratio and Identification of the Invasive Species Present in the Green Belt

- *Native Exotic Ratio*

There are a total of 84 varieties of species found during the survey of which 38 are exotic and 46 are native species.

Origin	Count
Exotic	38
Native	46
Grand Total	**84**

- *Identification of the Invasive Species*

  Leucaena leucocephala (Subabhul), the only invasive tree species, is primarily found in the Factory area but is present across the research region.

4. Carbon sequestration potential of the project area based on the tree inventory

- *Carbon Sequestration by trees was calculated using an allometric equation.*

Based on field studies, the green area was grouped into two strata, viz., dense vegetation, and sparse vegetation. For each stratum, the number of trees was calculated through the extrapolation method.

$$\text{Total trees in study area} = \text{Total number of } \frac{\text{Trees Sampled} \times \text{Total Tree Cover Area}}{\text{Total Sampled Area}}$$

To calculate carbon sequestration, the same species in each stratum were grouped together based on their girth value and the carbon sequestration value was obtained for the sampled species through allometric equation. This data was further extrapolated for the total area of each stratum.
Obtained values for all the strata were summed together to obtain the final carbon sequestration value.

Sample area Tree Count:

Sr. No.	Study Area	Sample Plots	Sample Area in ha	Trees in a sample area
1	Admin	27	0.8	748
2	Colony	149	4.7	7771
3	Plant	267	8.4	8219
Total		**443**	**13.9**	**16738**

Extrapolated Tree Count:

Sr. No.	Study Area	Area in Ha	Tree cover area in Ha	Extrapolated count	Total CS in tonnes
1	Admin	11	7.1	8411	519
2	Colony	69	53	64779	3998
3	Plant	204	53	51482	3177
Total		**283**	**112**	**124672**	**7695**

C. Gap identification and recommendations

1. Gap analysis of the existing greenbelt with Central and State Pollution Control Board Guidelines and any International Standards

- *Removal of Invasive Species*

2. Review of the plantation plan and methodology

- *Observations*

A few important observations made during the survey are highlighted: -

- A tree sapling was around 5 to 6 years of age.
- The pit size was 40x40x40 cm.
- The distance between the two trees was 2 m.

3. Review Water Availability and Quality

- RCFL presently is self-reliant in meeting its requirement of the precious resources of Water and Electricity. The water required for the green belt is provided by the Treated water plant.

4. Recommendations for complying with the best practices of maintenance of green belts.

- *Avoid pruning of trees*
- *Management of the trees*
- *Conservation of species:*

5. Recommendations for plantation on the restored land/open spaces etc.

- *Promote plantation of Native Species:*

6. Recommendations for upgradation with compliance for CPCB and SPCB Greenbelt requirements.

- Greenbelt refers to a buffer zone created beyond which industrial activity may not be carried on. comprehensive Guidelines for Developing Greenbelts have been compiled by the Central Pollution Control Board [Refer Probes/75/1999-2000].

  The Central Pollution Control Board (CPCB) has guidelines for developing green belts. The guidelines include:

  1. 33% of the total land area should be kept as greenbelt
  2. The species selected should be capable of growing fast, wind firm, and long lived
  3. The density of the trees should be around 2500 plants per ha
  4. The spacing between the trees should be 1 tree per 4 sq.m.
  5. The average width of the green belt will be around 10 m
  6. There would be at least 3 layers of plantation
  7. Short trees (<10 m height) will be planted in the first rows (towards plant side) of the green belt
  8. Tall trees (>10 m height) will be planted in the outer row (away from plant side)
  9. Water loving species will be planted in the row nearest to the reservoir rim

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Executive summary

Rashtriya Chemicals and Fertilizers Limited (RCFL) is a leading fertilizers and chemicals manufacturing company with about 75% of its equity held by the Government of India. Company has been accorded the coveted "Navratna" status in August 2023. It has two operating units, one at Trombay in Mumbai and the other at Thal, Raigad district, about 100 KM from Mumbai. Both the manufacturing units of RCFL are accredited with ISO 9001 (Quality Management System), ISO 14001 (Environmental Management System), ISO 45001 (Occupational Health and Safety), ISO 50001: 2011 (Energy Management System) and ISO 27001 (Information Security Management). RCFL manufactures Urea, Complex Fertilizers, Bio-fertilizers, Micro-nutrients, 100 percent water soluble fertilizers, soil conditioners and a wide range of Industrial Chemicals. Besides fertilizer products, RCFL also produces a large number of industrial chemicals that are important for the manufacture of dyes, solvents, leather, pharmaceuticals and a host of other industrial products. The "Ujjwala (Urea) and "Suphala" (Complex fertilizer) brands of fertilizers manufactured by RCFL carry high brand equity and are recognized brands all over the country. These products are taken to the farthest corner of the country by an extensive RCFL dealers network spread throughout the country.

Sustainability is core to RCFL's business. Their endeavour is to minimize their carbon footprint. Accordingly, RCFL has reformulated the CSR Policy which will guide sustainability initiatives in the years to come. RCFL has taken a number of initiatives to reduce energy consumption at both of its units – Trombay and Thal (Maharashtra).

In addition, RCFL has been focusing on water management to bring down water usage and conserve water at their plants. Almost 55% of the water requirement at Trombay is met through water generated from sewage treatment plants. The plant generates around 15 MLD of treated water.

To assess the **carbon sequestration** of overall green vegetation, extensive field survey and spatial analysis were carried out within the operational unit, colony and plantation areas. A stratified random sampling method was used for the sampling of trees. A Sampling plot of 10m was considered for the study. Attributes like the type of species, girth of the species, and height were noted during the sampling.

The CO_2 sequestration value of trees was calculated using the allometric equation for each site using cumulative values of Bole biomass, Above Ground Tree Biomass (AGTB) and total Biomass. Soil organic carbon was estimated through the Walkley & Black Method in the laboratory and carbon sequestration was estimated using the conversion factor. The overall carbon sequestration was thus calculated.

The study confirmed that the total carbon sequestration potential till date in the study area is 7,695 tonnes through the greenbelt area.

Study Area

The Rashtriya Chemicals and Fertilizers Limited (RCFL), has two operating units, one at Trombay in Mumbai and the other at Thal, Raigad district, about 100km from Mumbai. The Trombay unit is situated in central Mumbai and is surrounded by the neighbourhoods of Kurla, Mankhurd, Wadala, BKC, Trombay, Govandi, Chunabhatti, Vidyavihar and Ghatkopar. About the Trombay unit, it consists of three parts: the plant area, the admin area, and the residential colonies, each of which has an area of 212 ha, 10 ha, and 60 ha.

Figure 1 Study Area Images

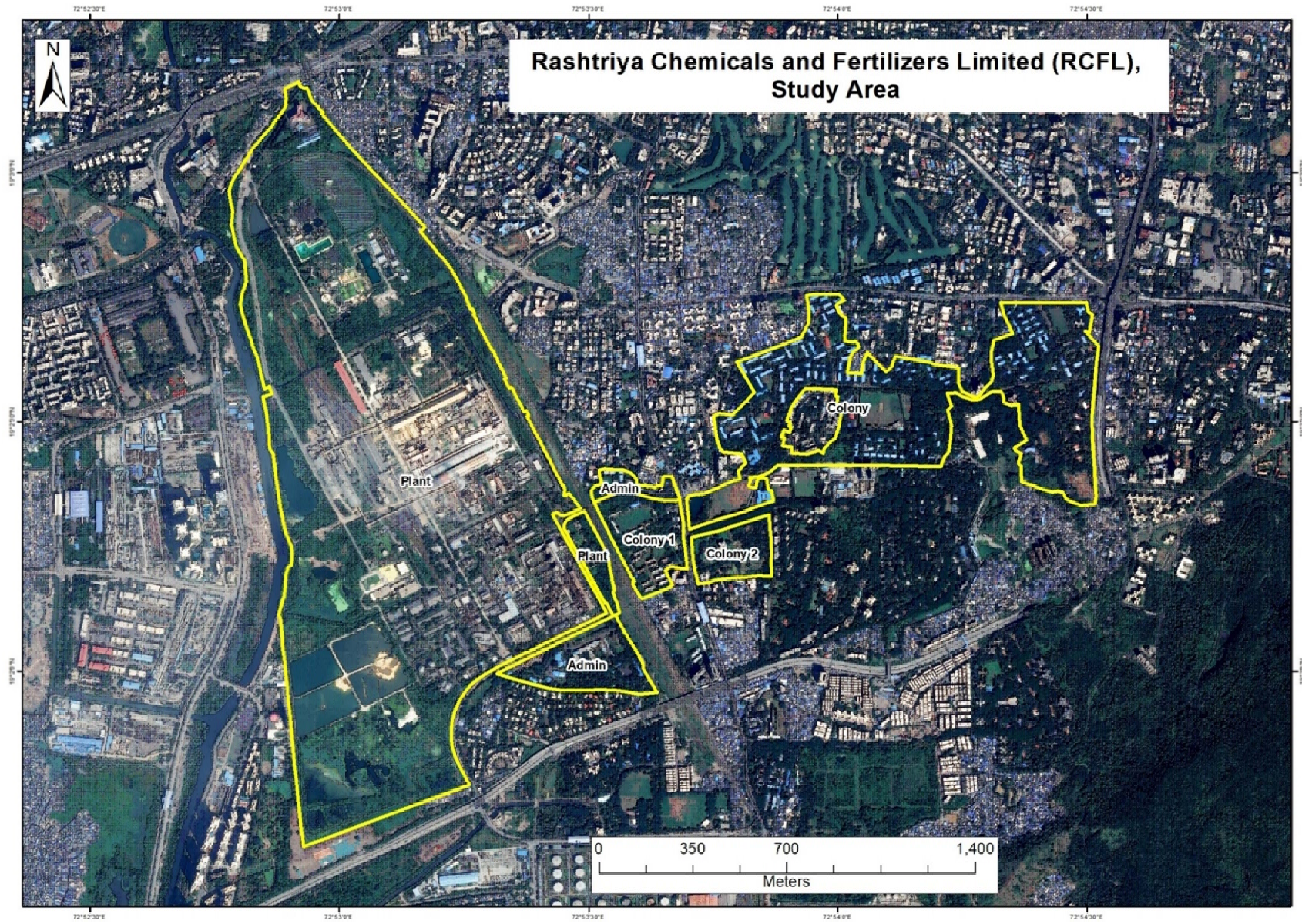


Figure 2 Study Area Map

Introduction

Greenbelt, often referred to as a "green lung" or "green corridor," is a vital concept in urban planning and environmental conservation. It represents a strategically planned area of open land, typically surrounding a city or metropolitan region, designated for preservation and protection from urban sprawl and development. The greenbelt serves as a natural buffer zone, safeguarding biodiversity, enhancing ecological balance, and providing numerous recreational opportunities for residents. Moreover, it contributes significantly to the mitigation of climate change by absorbing carbon dioxide and reducing the urban heat island effect. The establishment of greenbelts has become increasingly important in the face of rapid urbanization and its associated environmental challenges.

Greenbelt assessment plays a pivotal role in the sustainable land-use planning process, providing a comprehensive evaluation of green spaces and their ecological significance within urban environments. Greenbelts are designated areas of open land, often encircling cities or towns, aimed at preventing urban sprawl, conserving biodiversity, and maintaining the ecological balance. Through systematic evaluation and mapping of these green spaces, a greenbelt assessment aids policymakers and urban planners in making informed decisions that promote environmental conservation, enhance residents' quality of life, and foster resilient and sustainable communities. This assessment ensures that valuable natural resources are safeguarded, mitigates the adverse impacts of urbanization, and fosters the creation of more sustainable and liveable urban areas. To achieve these objectives, the assessment combines a multitude of factors, including biodiversity, habitat connectivity, land-use patterns, and stakeholder input, resulting in a holistic understanding of greenbelt areas and their critical role in shaping the future of urban landscapes.

A greenbelt assessment in the industry refers to an evaluation of the surrounding natural environment, open spaces, and potential green areas within or around industrial facilities or developments. The assessment aims to identify and protect areas that provide ecological, environmental, and social benefits while considering the impact of industrial activities on the local ecosystem.

Importance of Greenbelt Assessment in Industry:

1. Environmental Conservation: Greenbelt assessments help to identify and preserve ecologically significant areas such as wetlands, forests, and habitats for various plant and animal species. This protection ensures the maintenance of biodiversity and the natural balance of ecosystems.

2. Air Quality and Climate Mitigation: Green spaces play a vital role in improving air quality and reducing greenhouse gas emissions. Trees and vegetation absorb carbon dioxide and other pollutants, mitigating the environmental impact of industrial activities.

3. Water Management: Greenbelt assessments aid in the protection of water resources by preserving wetlands and natural drainage areas. These green spaces act as sponges, filtering pollutants and reducing the risk of flooding during heavy rainfall.

4. Sustainable Development: Incorporating greenbelts into industrial planning promotes sustainable development, striking a balance between economic growth and environmental preservation. This approach ensures the long-term viability of industrial projects.

5. Social Well-being: Green spaces offer recreational opportunities and contribute to the overall well-being of communities surrounding industrial areas. People can use these areas for leisure, exercise, and relaxation, improving their physical and mental health.

Carbon sequestration

Carbon sequestration is the process by which atmospheric carbon dioxide is taken up by trees, grasses, and other plants through photosynthesis and stored as carbon in biomass (trunks, branches, foliage, and roots).

Plants perform photosynthesis by absorbing CO_2 from the air, binding it up in sugar and releasing O_2. The carbon is fixed in the sugar molecule to build wood, branches, and roots. Wood is an incredible carbon sink because it is made entirely of carbon, it lasts for years as a standing tree, and takes years to break down after the tree dies. While trees mainly store carbon, they do release some carbon, such as when their leaves decompose, or their roots burn sugar to capture nutrients and water. Trees act as natural purifiers by captivating carbon in their biomass and hence are considered potential carbon sinks.

Consequently, terrestrial vegetation plays an important role in biodiversity conservation and in maintaining the level of carbon dioxide in the atmosphere besides improving the green infrastructure and ornamentation of the urban landscape. Each tree species has its role in contributing to the betterment of the environment, for example, carbon storage also varies according to the type of species (Kothandaraman S, 2020).

India has pledged to reduce total projected carbon emissions by up to 1 billion tonnes by 2030 and achieve net zero emissions by the year 2070 apart from other ambitious climate change targets in the recently held COP27 summit in Egypt (Kulkarni, 2022). India's nationally determined contribution (NDC), to sequester an additional 2.5-to-3-billion-tonnes carbon dioxide (CO_2) equivalent by 2030 under the Paris Climate Agreement, can be achieved by integrating trees in multiple land uses. A slight increase in carbon capture can help achieve India's climate change targets (Chavhan 2022).

The green vegetation and soils constitute a major carbon reservoir of the terrestrial carbon cycle. The CO_2 source and sink dynamics as trees grow, die, and decay is subjected to disturbance and management. Aluminium is a crucial material for key industries like construction, transportation and power transmission. The demand for the metal is likely to increase in the future with an increase in development making it necessary for the industry to control its overall global emissions through the inclusion of green cover and upgraded technologies. Carbon sequestration studies can provide a baseline for understanding the current carbon emission of the industry and set targets to achieve its net zero emission goals.

GIS Processing

Land use and land cover studies use GIS and remote sensing technologies that have proven to be a cost-effective and timely assessment of land use. Utilizing such technologies helps in better management of industrial areas and their peripheries. The satellite imagery is processed in ArcGIS software to remove any effects of haze, smoke, and cloud cover. The satellite data in the form of multispectral imagery consists of data obtained on different wavelengths in an electromagnetic spectrum. These data can be used to calculate vegetation indices for obtaining the amount of green cover. Vegetation indices are combinations or transformations of spectral bands in remote sensing to give prominence to the spectral properties of plants and other types of vegetation. This makes them stand out from other features allowing us to calculate the cover of vegetation in a particular area.

Recently green spaces or green cover have become significant in urban planning. The integration of green infrastructure, green parks, and recreational spaces has been started in urban environments. This is done by utilizing GIS and remote sensing technologies. Green cover can be mapped using either remotely

sensed data obtained from satellite, drones, or aircraft or digitization of green areas using GIS software like ArcGIS, ERDAS, QGIS, etc. The satellite data in form of multispectral imagery consist of data obtained on different wavelengths in an electromagnetic spectrum. These data can be used to calculate vegetation indices for obtaining the amount of green cover.

Vegetation indices are combinations or transformations of spectral bands in remote sensing to give prominence to spectral properties of plants and other types of vegetation. This makes them stand out from other features allowing us to calculate the cover of vegetation in a particular area. Vegetation indices are capable of providing us information like percentage green cover, biomass, and leaf area index. The calculations of these indices depend upon the difference between the reflectance and absorption capabilities of plants. Since plants reflect more in the near-infrared region and green region of the electromagnetic spectrum and absorb the rest of wavelengths like red, blue, and green, the difference between NIR and red bands allowing us to extract vegetation features. Temporal analysis of vegetation indices allows us to track changes in the amount of green cover as well as its health.

Assessment of Greenbelt

A. Quantitative assessment of percentage green cover using GIS techniques

1. Procurement of the recent high-resolution satellite imagery

- *Satellite imagery map and details*

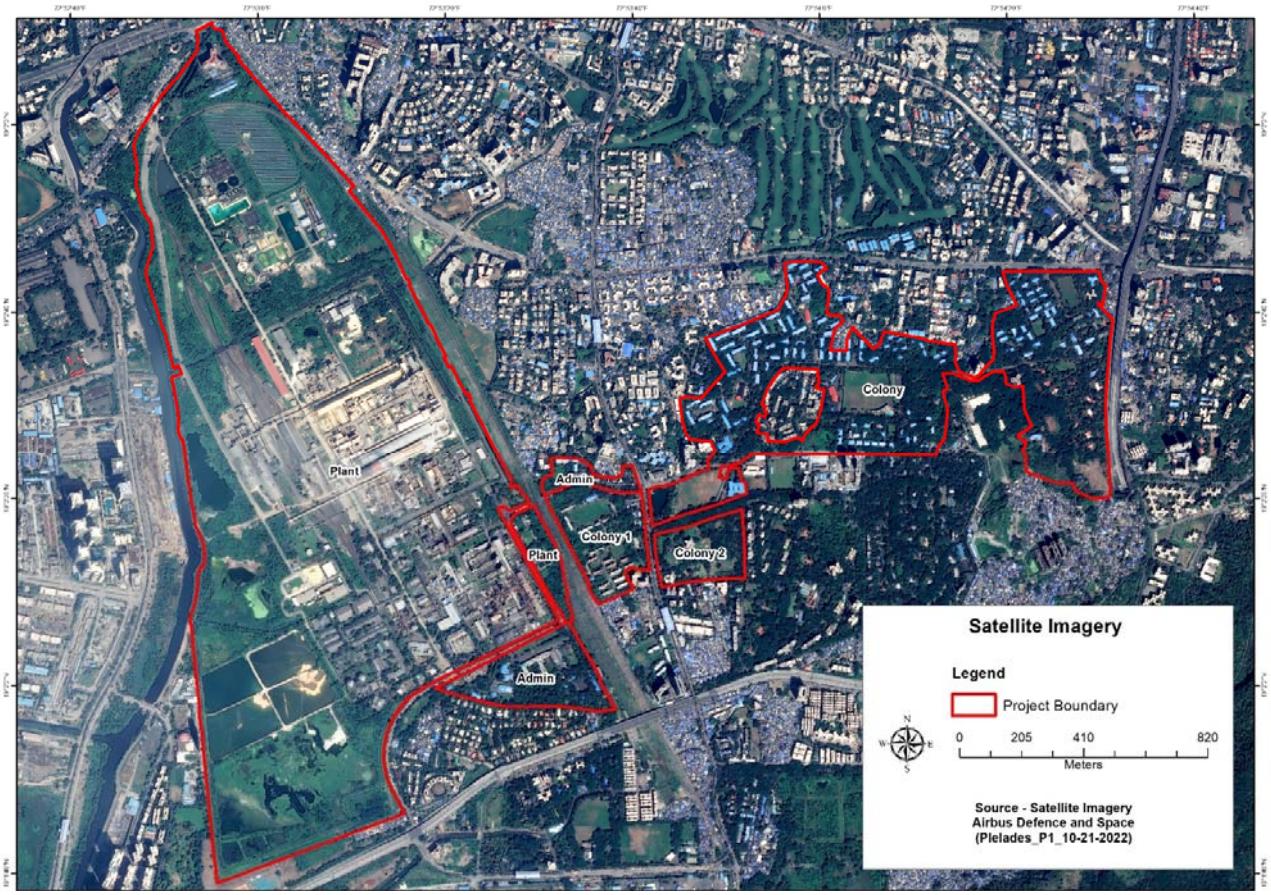


Figure 3 Satellite Imagery

For the estimation of green cover in Rashtriya Chemicals & Fertilizers Limited, MSAVI, a modified version of the NDVI index was used. MSAVI- 2 minimizes the effects of soil spectral signatures this assist in the extraction of only vegetation pixel rather than mixed pixels of soil and vegetation which sometimes happens in the case of NDVI.

For the calculation of MSAVI-2, Airbus satellite imagery *i.e.,* Pleiades P1 was procured. Worldview-3 product has a spatial resolution of 0.5m. It was licensed by Airbus Defence and Space. A tool called "indices" from ERDAS software was used to carry out unsupervised classification.

Note: Satellite imagery is also submitted in Pen drive.

2. Calculation of the proportion of Green Cover of the Study Area using GIS tools

Sr. No.	Study Area	Total Plot Area in Ha	Green Cover Area in Ha	Percentage
1	Admin	11	9	84%
2	Colony	69	57.1	83%
3	Plant	204	110	54%
	Total	**283**	**176**	**62.20%**

Table 1 Green Cover Count

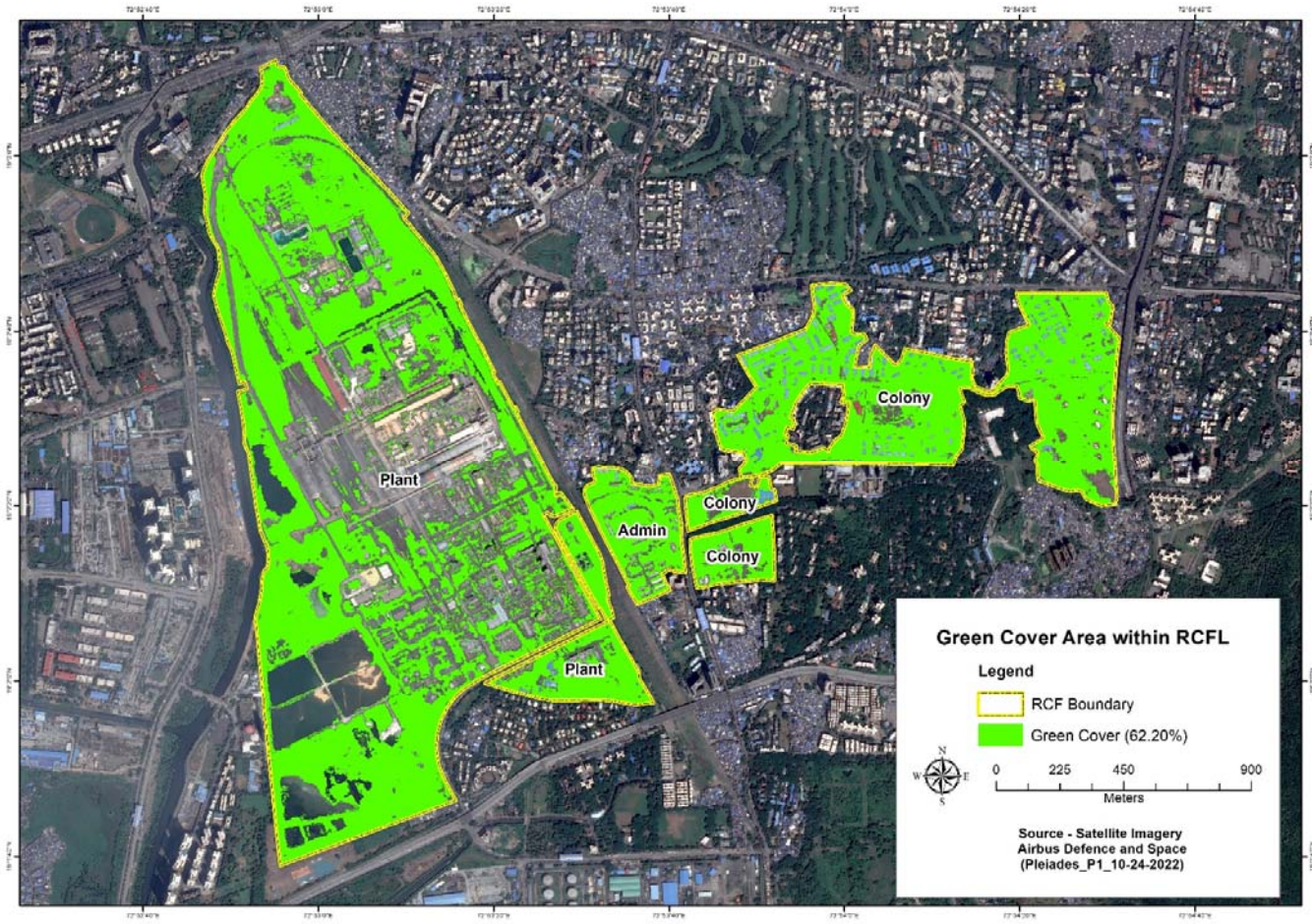


Figure 4 Green Cover Map

3. Calculation of the proportion of Tree Cover/Greenbelt of the Study Area using GIS tools

Sr. No.	Study Area	Total Plot Area in Ha	Tree Cover Area in Ha	Percentage
1	Admin	11	7.1	66%
2	Colony	69	53	77%
3	Plant	204	53	26%
	Total	**283**	112	**39.69%**

Table 2 Tree Canopy Cover Count

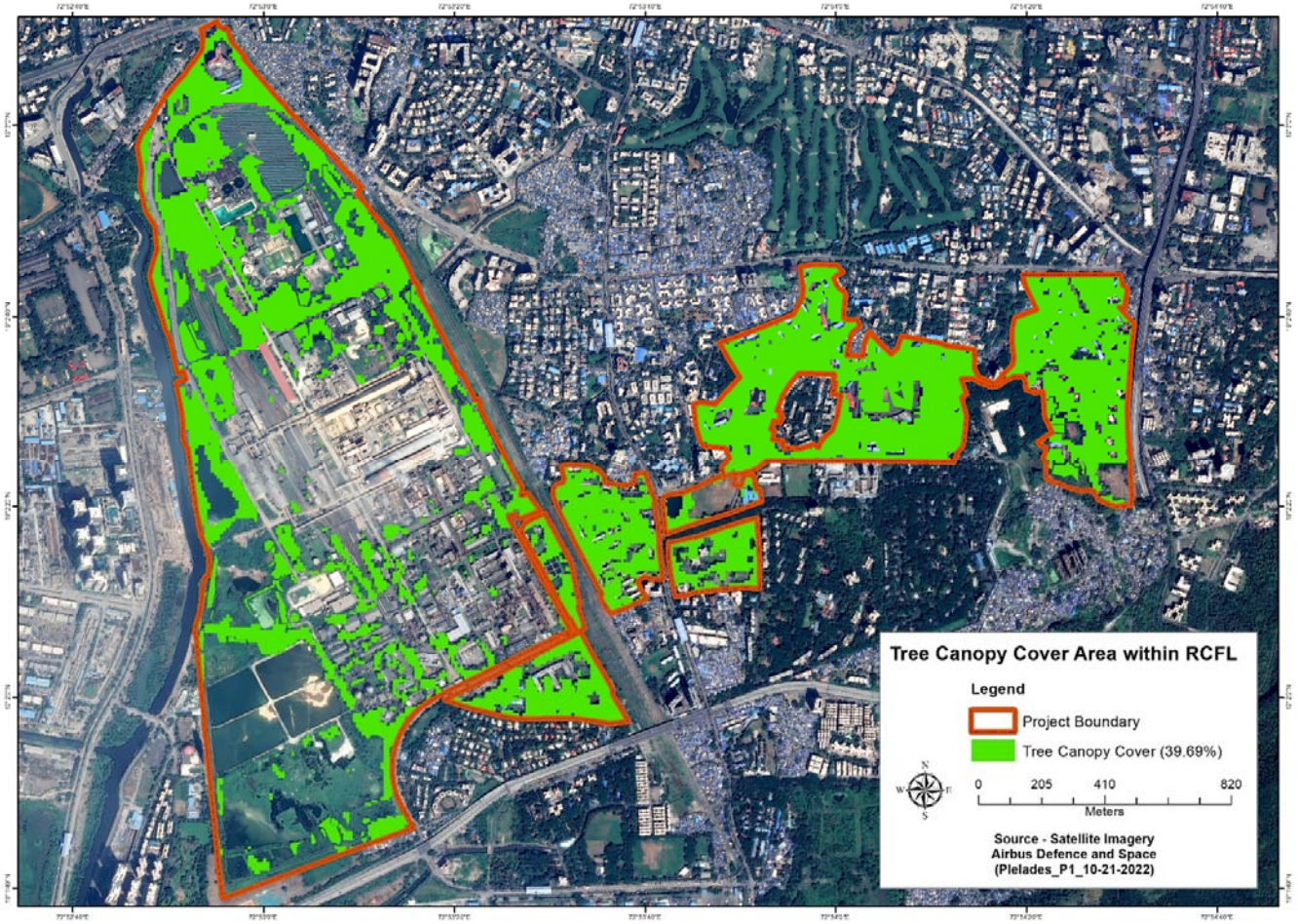


Figure 5 Tree Cover Map

- *Green cover and Tree Cover calculation methodology*

NDVI or Normalized Difference Vegetation Index is a remote sensing GIS method that uses the reflectance of light in the visible and near-infrared (NIR) wavelengths to determine the amount and health of vegetation in an area. Normalized Difference Vegetation Index (NDVI) uses the NIR and red channels in its formula. Healthy vegetation (chlorophyll) reflects more near-infrared (NIR) and green light compared to other wavelengths.

NDVI is calculated by subtracting the reflectance of the NIR band from the reflectance of the red band and then dividing that value by the sum of the reflectance of the NIR and red bands. NDVI values range from -1 to 1, with -1 indicating no vegetation, 0 indicating bare soil or water, and values closer to 1 indicating greater amounts and healthier vegetation.

The formula for the evaluation of NDVI is

Normalized Difference Vegetation Index (NDVI) = (NIR-Red)/(NIR+Red)

The values range from -1 to +1 indicating all vegetation cover including lawns and shrubs, which is called Green Cover, followed by tree leaf cover, which is called Tree Canopy Cover after adjustment in the same range.

B. Qualitative assessment - vegetation study of existing green belt

1. Study of existing and previous green belt/vegetation including tree count and identification of the tree species (Plot Count)

Sr. No.	Study Area	Sample Plots Count	Sample Area in ha	Trees in the sample area
1	Admin	27	0.8	748
2	Colony	149	4.7	7771
3	Plant	267	8.4	8219
	Total	**443**	**13.9**	**16738**

Table 3 Sample Area Study

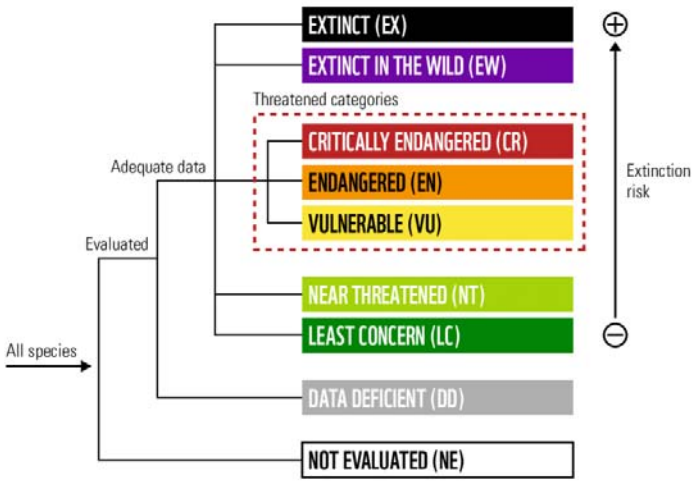
Sr. No.	Study Area	Total Area in Ha	Tree cover area in Ha	Total tree count
1	Admin	11	7.1	8411
2	Colony	69	53	64779
3	Plant	204	53	51482
Total		**283**	**112**	**124672**

Table 4 Tree Count Analysis

2. Provide ecological insight in terms of diversity map, phytosociological studies, rare species, endemism, and seasonality

- *IUCN Red List*

  The **International Union for Conservation of Nature** Red List of Threatened Species (IUCN Red List) was founded in 1964. It is a comprehensive inventory that provides the global



conservation status of several species. It uses a set of criteria to evaluate species and categorise them into nine categories, i.e., Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, and Extinct. The species are evaluated in their native zone and may not be of concern in other countries.

Following are the tree species found during site survey.

Sr. No.	Scientific Name	Common Name	Family	Habit	Origin	IUCN Category
Native tree species						
1	*Adenanthera pavonina*	Red bead tree	Fabaceae	Tree	Native	LC
2	*Alstonia scholaris*	Scholars tree	Apocynaceae	Tree	Native	LC
3	*Artocarpus heterophyllus*	Jackfruit tree	Moraceae	Tree	Native	-
4	*Bauhinia purpurea*	Purple orchid tree	Caesalpiniaceae	Tree	Native	LC
5	*Bauhinia variegata*	Kachnar	Fabaceae	Tree	Native	LC
6	*Bergera koenigii*	Curry leaf	Rutaceae	Tree	Native	LC
7	*Bombax ceiba*	Silk Cotton tree	Malvaceae	Tree	Native	LC
8	*Borassus flabellifer*	Toddy palm	Arecaceae	Tree	Native	LC
9	*Bridelia retusa*	Spinous kino tree	Phyllanthaceae	Tree	Native	LC
10	*Broussonetia papyrifera*	Paper mulberry	Moraceae	Tree	Native	LC
11	*Caryota urens*	Fishtail palm	Arecaceae	Tree	Native	LC
12	*Cassia fistula*	Amaltas	Fabaceae	Tree	Native	LC
13	*Casuarina equisetifolia*	Whistling pine	Casuarinaceae	Tree	Native	LC
14	*Crateva magna*	Garlic pear tree	Capparaceae	Tree	Native	-
15	*Dalbergia sissoo*	Indian rosewood	Fabaceae	Tree	Native	LC
16	*Ficus benghalensis*	Banyan tree	Moraceae	Tree	Native	-
17	*Ficus benjamina*	Weeping fig	Moraceae	Tree	Native	LC
18	*Ficus hispida*	Hairy Fig	Moraceae	Tree	Native	LC
19	*Ficus racemosa*	Umber	Moraceae	Tree	Native	LC
20	*Ficus religiosa*	Sacred fig tree	Moraceae	Tree	Native	LC
21	*Firmiana colorata*	Scarlet Sterculia	Malvaceae	Tree	Native	LC
22	*Grewia tiliifolia*	Dhaman	Malvaceae	Tree	Native	-
23	*Holoptelea integrifolia*	Indian elm	Ulmaceae	Tree	Native	-
24	*Hydnocarpus pentandrus*	Jangli almond	Achariaceae	Tree	Native	VU
25	*Lagerstroemia speciosa*	Queen Crepe Myrtle	Lythraceae	Tree	Native	-
26	*Magnolia champaca*	Champak	Magnoliaceae	Tree	Native	LC
27	*Mimusops elengi*	Spanish cherry	Sapotaceae	Tree	Native	LC
28	*Monoon longifolium*	False ashok	Annonaceae	Tree	Native	-
29	*Morinda coreia*	Indian mulberry	Rubiaceae	Tree	Native	-
30	*Moringa oleifera*	Shevga	Moringaceae	Tree	Native	LC
31	*Neolamarckia cadamba*	Kadam	Rubiaceae	Tree	Native	-
32	*Nyctanthes arbor-tristis*	Parijat	Oleaceae	Tree	Native	LC
33	*Pongamia pinnata*	Pongam tree	Fabaceae	Tree	Native	LC
34	*Putranjiva roxburghii*	Putranjiva	Putranjivaceae	Tree	Native	LC
35	*Sapindus mukorossi*	Soapberry	Sapindaceae	Tree	Native	LC
36	*Saraca asoca*	Sita ashok	Fabaceae	Tree	Native	VU
37	*Senegalia catechu*	Catechu	Fabaceae	Tree	Native	LC
38	*Sterculia foetida*	Wild Indian Almond	Malvaceae	Tree	Native	-
39	*Syzygium cumini*	Black plum	Myrtaceae	Tree	Native	LC
40	*Talipariti tiliaceus*	Sea hibiscus	Malvaceae	Tree	Native	LC
41	*Tectona grandis*	Teak	Lamiaceae	Tree	Native	EN
42	*Terminalia bellirica*	Baheda	Combretaceae	Tree	Native	LC

Sr. No.	Scientific Name	Common Name	Family	Habit	Origin	IUCN Category
43	*Terminalia catappa*	Indian almond	Combretaceae	Tree	Native	LC
44	*Terminalia elliptica*	Asan	Combretaceae	Tree	Native	-
45	*Thespesia populnea*	Indian tulip tree	Malvaceae	Tree	Native	LC
46	*Trema orientale*	Indian charcoal tree	Cannabaceae	Tree	Native	LC
47	*Ziziphus mauritiana*	Ber	Rhamnaceae	Tree	Native	LC
Exotic tree species						
48	*Acacia mearnsii*	Black wattle	Fabaceae	Tree	Exotic	-
49	*Acacia melanoxylon*	Australian blackwood	Fabaceae	Tree	Exotic	-
50	*Annona reticulata*	Custard apple	Annonaceae	Tree	Exotic	LC
51	*Annona squamosa*	Custard apple	Annonaceae	Tree	Exotic	LC
52	*Areca catechu*	Betel palm	Arecaceae	Tree	Exotic	DD
53	*Azadirachta indica*	Neem	Meliaceae	Tree	Exotic	LC
54	*Canarium vulgare*	Java almond	Burseraceae	Tree	Exotic	LC
55	*Cocos nucifera*	Coconut tree	Arecaceae	Tree	Exotic	-
56	*Couroupita guianensis*	Cannon ball tree	Lecythidaceae	Tree	Exotic	LC
57	*Crescentia cujete*	Calabash tree	Bignoniaceae	Tree	Exotic	-
58	*Delonix regia*	Gulmohar	Fabaceae	Tree	Exotic	LC
59	*Eucalyptus globulus*	Blue gum tree	Myrtaceae	Tree	Exotic	LC
60	*Ficus elastica*	Indian rubber tree	Moraceae	Tree	Exotic	LC
61	*Gliricidia sepium*	Mother of cocoa	Fabaceae	Tree	Exotic	LC
62	*Grevillea robusta*	Silver oak	Proteaceae	Tree	Exotic	LC
63	*Handroanthus chrysotrichus*	Golden trumpet tree	Bignoniaceae	Tree	Exotic	-
64	*Kalanchoe laciniata*	Christmas tree	Crassulaceae	Tree	Exotic	-
65	*Kigelia africana*	Sausage tree	Bignoniaceae	Tree	Exotic	LC
66	*Leucaena leucocephala*	Subabhul	Fabaceae	Tree	Exotic	-
67	*Mangifera indica*	Mango	Anacardiaceae	Tree	Exotic	DD
68	*Manilkara zapota*	Chikoo	Sapotaceae	Tree	Exotic	LC
69	*Millettia peguensis*	Moulmein rosewood	Fabaceae	Tree	Exotic	DD
70	*Morus alba*	White mulberry	Moraceae	Tree	Exotic	LC
71	*Muntingia calabura*	Singapore cherry	Muntingiaceae	Tree	Exotic	-
72	*Myroxylon balsamum*	Peru balsam	Fabaceae	Tree	Exotic	LC
73	*Pachira insignis*	Showy silk cotton tree	Malvaceae	Tree	Exotic	LC
74	*Peltophorum pterocarpum*	Copperpod	Fabaceae	Tree	Exotic	-
75	*Phyllanthus acidus*	Rai avla	Phyllanthaceae	Tree	Exotic	-
76	*Pithecellobium dulce*	Sweet tamarind	Fabaceae	Tree	Exotic	LC
77	*Plumeria obtusa*	White frangipani	Apocynaceae	Tree	Exotic	LC
78	*Psidium guajava*	Guava	Myrtaceae	Tree	Exotic	LC
79	*Ravenala madagascariensis*	Traveller's palm	Strelitziaceae	Tree	Exotic	LC
80	*Roystonea regia*	Royal bottle palm	Arecaceae	Tree	Exotic	LC
81	*Samanea saman*	Rain tree	Fabaceae	Tree	Exotic	LC

Sr. No.	Scientific Name	Common Name	Family	Habit	Origin	IUCN Category
82	*Senna siamea*	Siamese cassia	Fabaceae	Tree	Exotic	LC
83	*Spathodea campanulata*	Africaum tulip	Bignoniaceae	Tree	Exotic	LC
84	*Syzygium samarangense*	Wax apple	Myrtaceae	Tree	Exotic	LC
85	*Tamarindus indica*	Tamarind	Fabaceae	Tree	Exotic	LC
86	*Tecoma stans*	Yellow bells	Bignoniaceae	Tree	Exotic	LC

Table 5 Tree Species Inventory

2.1 Species density

Tree species density refers to the number of different species of trees within a specific area or ecosystem. It is a measure of biodiversity within a forest or wooded area and is often used to assess the health and ecological diversity of a particular environment. Higher tree species density typically indicates a more diverse and ecologically complex forest, while lower tree species density may suggest a less diverse or potentially degraded ecosystem.

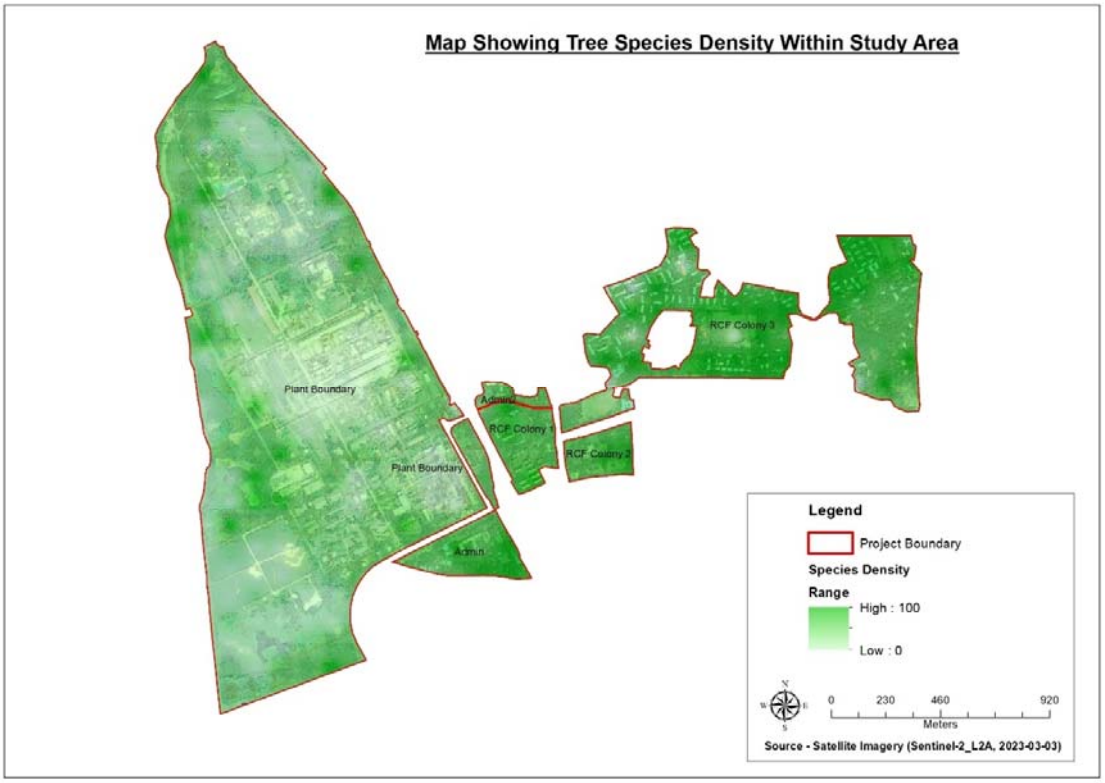


Figure 6 Species Density Map

2.2 Phytosociological studies

- Aesthetically and Economically Important tree species

  In numerous manners, trees improve their surroundings. The eye gets diverted by trees that were planted close to and around buildings, softening the background and hiding unpleasant vistas. The different shades of green seen in leaves, the colors found in flowering trees, and sometimes even the tree's bark, are all ways that trees add beautiful hues to their surroundings.

  A tree's leaves, branches, stems, bark, fruits, seeds, and roots are all beneficial. The wood, timber, raw materials, and fruits that trees produce have high economic worth. Also, wood is necessary for the manufacture of paper. Even green garbage is important economically.

  The following species which have aesthetic and economic value were noted during a survey and are also recommended for plantation purposes within Colony and admin areas:

Tree Species	Importance	Origin
Alstonia scholaris	Aesthetic	Native
Bauhinia purpurea	Aesthetic	Native
Cassia fistula	Aesthetic	Native
Ficus benjamina	Aesthetic	Native
Lagerstroemia speciosa	Aesthetic	Native
Magnolia champaca	Aesthetic	Native
Nyctanthes arbor-tristis	Aesthetic	Native
Saraca asoca	Aesthetic	Native
Senna siamea	Aesthetic	Native
Thespesia populnea	Aesthetic	Native
Delonix regia	Aesthetic	Exotic
Peltophorum pterocarpum	Aesthetic	Exotic
Plumeria alba	Aesthetic	Exotic
Roystonea regia	Aesthetic	Exotic
Acacia catechu	Economical	Native
Artocarpus heterophyllus	Economical	Native
Azadirachta indica	Economical	Native
Bergera koenigii	Economical	Native
Borassus flabellifer	Economical	Native
Cocos nucifera	Economical	Native
Mangifera indica	Economical	Native
Moringa oleifera	Economical	Native
Morus alba	Economical	Native
Phyllanthus emblica	Economical	Native
Psidium guajava	Economical	Native
Sapindus trifoliatus	Economical	Native
Syzygium cumini	Economical	Native
Tectona grandis	Economical	Native
Terminalia bellirica	Economical	Native
Terminalia catappa	Economical	Native
Ziziphus mauritiana	Economical	Native

Tree Species	Importance	Origin
Annona squamosa	Economical	Exotic
Tamarindus indica	Economical	Exotic

Table 6 Phytosociological studies in Colony & Admin office

- *Important trees in the context of air quality and dust-prevention*

  Large leaves aid in reducing the amount of dust that spreads across the area. Particles, smells, and polluting gases including carbon monoxide, nitrogen oxides, and ammonia gather on a tree's leaves. Trees absorb these harmful substances from their surroundings, effectively filtering them out. By absorbing heat, lowering ground-level ozone levels, and releasing the breathing that sustains life, trees also help to lessen the impact of greenhouse gases on the environment.

  The following species recommended for plantation purposes within factory area:

Tree Species	Importance	Origin
Casuarina equisetifolia	Pollution tolerant	Native
Ficus elastica	Pollution tolerant	Native
Ficus hispida	Pollution tolerant	Native
Ficus religiosa	Pollution tolerant	Native
Ficus virens	Pollution tolerant	Native
Neolamarckia cadamba	Pollution tolerant	Native
Pongamia pinnata	Pollution tolerant	Native
Acacia auriculiformis	Pollution tolerant	Exotic
Kigelia africana	Pollution tolerant	Exotic
Monoon longifolium	Pollution tolerant	Exotic

Table 7 Phytosociological studies in Factory

3. Photo pictures of rare uncommon species, plants, and trees to be captured and included in the report

Borassus flabellifer **(Toddy Palm)**

Mangifera indica **(Mango)**

Ficus benghalensis **(Banyan tree)**

Tectona grandis **(Teak)**

Cocos nucifera **(Coconut tree)**

Monoon longifolium **(False ashok)**

Saraca asoca **(Sita ashok)**

Pongamia pinnata **(Pongam tree)**

Kigelia Africana **(Sausage tree)**

Bauhinia purpurea **(Purple orchid tree)**

Gliricidia sepium **(Mother of cocoa)**

Azadirachta indica **(Neem)**

Ficus elastica **(Indian rubber tree)**

Ficus hispida **(Hairy fig)**

Adenanthera pavonina **(Red bead tree)**

Artocarpus heterophyllus **(Jackfruit tree)**

Caryota urens **(Fishtail palm)**

Delonix regia **(Gulmohar)**

Ficus religiosa **(Sacred fig tree)**

Syzygium samarangense **(Water apple)**

Figure 7 Documented tree species

4. Calculating the Native to Exotic Ratio and Identification of the Invasive Species Present in the Green Belt

Native plants have long been a source of food and shelter for animals like birds and butterflies. These populations are susceptible to rapid declines if there aren't enough native trees present. That's why it's crucial to plant native trees.

- *Native Exotic Ratio*

  There are a total of 84 varieties of species found during the survey of which 38 are exotic and 46 are native species.

Origin	Count
Exotic	38
Native	46
Grand Total	**84**

Table 8 Native to Exotic Ratio

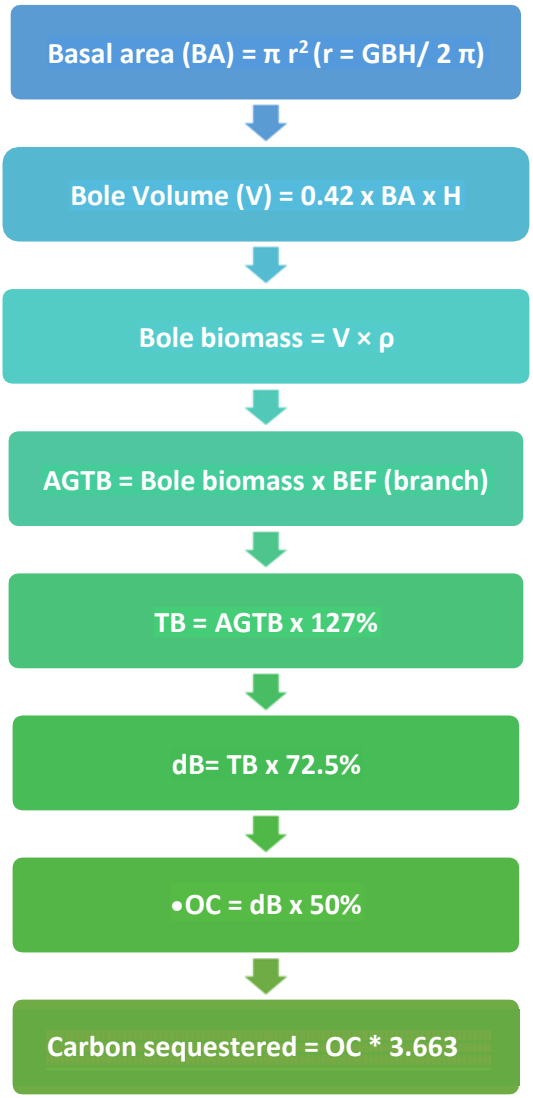
- *Identification of the Invasive Species*

  Leucaena leucocephala (Subabhul), the only invasive tree species, is primarily found in the Factory area but is present across the research region.

  Leucaena leucocephala, a fast-growing, nitrogen-fixing tree, is grown for feed, green manure, windbreaks, reforestation, biofuel, and other purposes. Leucaena has been widely introduced due to its advantageous traits; nonetheless, in disturbed areas of many tropical and subtropical locations, it has turned into an aggressive invader and is named one of the "100 of the World's Worst Invasive Alien Species." Once established, this thornless tree can grow into dense monospecific thickets and is challenging to remove. It damages native vegetation and makes large areas inaccessible and useless.

5. Carbon sequestration potential of the project area based on the tree inventory

- *Carbon Sequestration by trees was calculated using an allometric equation.*



Where,

- BA is tree basal area [cm^3] at breast height
- H is tree merchantable height [cm]
- 0.42 is multiplication factor as tree volume often lying between 0.40 and 0.45 times that of an equivalent cylinder
- ρ is wood density [g cm^3] specific to each tree species will be obtained through secondary sources
- BEF = Branch Expansion Factor which is 1.5 obtained through secondary sources (IPCC, 2003)
- 127% will be total above and below ground biomass (IPCC, 2003)
- AGTB = above-ground tree biomass
- dB = Dried biomass (g)
- TB = total biomass (g)

72.5% is the dry matter of tree

The important parameters taken into consideration to calculate Carbon sequestration are girth (cm), height (cm), radius (cm), Bole Volume (cm^3), Wood Density (g/cm^3) obtained fromsecondary sources, Bole Biomass (g), Above Ground Tree Biomass (AGTB) (g), Total Biomass (g), Below Ground Tree Biomass (BGTB) (g), Dried Biomass (g), Organic Carbon (g) and lastly converting the 'g' values to 'kg' for CO_2 sequestration [Beets et al., 2012]. The CO_2 sequestration value is calculated for each site using cumulative values of Bole biomass, AboveGround Tree Biomass (AGTB), and Total Biomass [Ravindranath and Ostwald, 2008]. The calculation provides value obtained through Carbon Sequestration till date of data collection.

Bole volume

Tree shapes can be considered in various shapes (www.ifmlab.for.unb.ca). Trees are neither cones nor cylinders, but empirical analyses often indicate that the volume of a single-stemmed tree is between that of a cone and a cylinder, with tree volume often lying between 0.40 and 0.45 times that of an equivalent cylinder. The volume of a cylinder is the area of the base times the height, and the volume of a cone is one-third of the volume of a cylinder with the same area of the base and height (FAO 2004). Using a value of 0.42, an equation can be developed to estimate the cubic volume of wood in the absence of local equations as given below.

In the absence of local equations, the cubic volume of wood for standing trees may be estimated by the following equation:

V = 0.42 x BA x H

Where,

- BA is tree basal area [cm3] at breast height and
- H is tree merchantable height [cm]

For the calculation of Basal area from Radius, the formula is

Basal area (BA) = πr^2

Where,

- r= Radius [cm];

For the calculation of the Radius from GBH, the formula is

r = GBH/ 2 π

where,

-

Fresh weight of Bole biomass

Bole biomass is estimated through allometric equations, which were developed for 107 tree species. A mixed-species tree equation based on breast height diameter (DBH) and tree height (H) provides acceptable estimates of stem plus branch (>10 cm in diameter over bark) volume (Chave et al. 2005; Beets et al. 2012). For the calculation of Bole biomass (Ravindranath and Ostwald 2008), the following is the equation:

Bole biomass = V × ρ

Where,

Bole biomass = Bole biomass [g]

V = Volume of tree [cm3]

ρ = wood density [g cm3] specific to each tree species

The wood densities (WD) were obtained from various sources but mainly from https://www.worldagroforestycentre.org; FAO 1997; Reyes et al. 1992

Aboveground tree biomass (AGTB)

To calculate the Fresh above-ground biomass, the bole biomass should be multiplied with the Biomass expansion factor (IPCC 2003). This will give the fresh volume of the aboveground biomass including the branches.

AGTB = Bole biomass x BEF (branch)
Where,
AGTB = above-ground tree biomass [g];
BEF = Biomass Expansion Factor which is 1.5

Total Above and Below ground biomass (TB)
Below-ground biomass was calculated considering 0.27 of the above-ground biomass (IPCC 2003) so, for simplification of the equation it is considered as 127% will be the total above and below-ground biomass.
TB = AGTB x 127%
Where,
AGTB = above-ground tree biomass [g];

Conversion of fresh weight to dry weight
The average tree is 72.5% dry matter and 27.5% moisture (DeWald et al. 2013). Therefore, to determine the dry biomass (Db) of the tree, multiply the weight of the tree by 72.5%.
dB= TB x 72.5%
Where,
dB = Dried biomass [g];
TB = total biomass [g];

Organic carbon
The biomass carbon will be calculated using the stock method. The carbon content is estimated to be 50 % of biomass (MacDicken 1997).
OC = dB x 50%
Where,
OC= Organic content [g] dB= Dried biomass [g]

Determination of the weight of CO2 sequestered in a tree
CO_2 is composed of one molecule of Carbon and two molecules of Oxygen
The atomic weight of Carbon is 12.001115
The atomic weight of Oxygen is 15.9994
The weight of CO2 is C+2*O=43.999915
The ratio of CO2 to C is 43.999915/12.001115=3.6663
Therefore, to determine the weight of carbon dioxide sequestered in the tree, multiply the weight of carbon in the tree by 3.6663 (Saral et.al. 2017).

Classification system and nomenclature
The Plant list (TPL | http://www.theplantlist.org/1.1/) was followed for the recent scientific names (nomenclature) of the plants (here, recent and accepted names). Obligatory to this is to follow the classification of Angiosperm Phylogeny Group III (APG III), which is based on the molecular taxonomy. Sometimes there are remarkable differences in the scientific names and names of the families in comparison with old/conventional classification system.

Determining the GBH and Height values
Limitation: The variables such as tree, height and girth, are dependent on the climate, soil, and a variety of other factors. Therefore, individuals of the same species even present within the same locality may

have different heights and girth. It is practically impossible to calculate exact tree height and therefore most of the studies consider approximation while calculating tree height.

Specific consideration: Girth and height used for this project are generated using the database of Terracon Ecotech Pvt. Ltd. As per the requirement of the study or project which has been assigned to Terracon, the GBH along with approximate height and age of tree species were recorded. For this assignment, all such entries were pooled together. However, as mentioned in the limitations, there could be variations in girth and height. The data is, thus, grouped in various class intervals, and outliers, if any, were excluded. The maximum occurrence of GBH and height value, within the same class interval/category were then considered for that specific age group.

Calculations to Estimate the total amount of CO_2 Sequestration

To estimate the carbon sequestration value, three factors were considered, viz., the density of the plantation, the girth of the species, and the total number of species with similar girth.

Based on field studies, the green area was grouped into two strata, viz., dense vegetation, sparse vegetation. For each stratum, the number of trees was calculated through the extrapolation method.

$$\text{Total trees in study area} = \text{Total number of } \frac{\text{Trees Sampled} \times \text{Total Tree Cover Area}}{\text{Total Sampled Area}}$$

To calculate carbon sequestration, the same species in each stratum were grouped together based on their girth value and the carbon sequestration value was obtained for the sampled species through allometric equation. This data was further extrapolated for the total area of each stratum.
Obtained values for all the strata were summed together to obtain the final carbon sequestration value.

Sr. No.	Study Area	Sample Plots	Sample Area in ha	Trees in a sample area
1	Admin	27	0.8	748
2	Colony	149	4.7	7771
3	Plant	267	8.4	8219
Total		**443**	**13.9**	**16738**

Table 9 Sample Area Study Analysis

Sr. No.	Study Area	Area in Ha	Tree cover area in Ha	Extrapolated count	Total CS in tonnes
1	Admin	11	7.1	8411	519
2	Colony	69	53	64779	3998
3	Plant	204	53	51482	3177
Total		**283**	**112**	**124672**	**7695**

Table 10 Carbon Sequestration Analysis

C. Gap identification and recommendations

1. Gap analysis of the existing greenbelt with Central and State Pollution Control Board Guidelines and any International Standards

Gap analysis determines if an important species is present in an area or not; if it is, to decide if it is adequately protected or not or if additional conservation efforts are needed for the particular species. Secondly, there are the ecological gaps, which determine the adequacy of the protected area taking into consideration the natural habitat of a species as well as that species' movement

- *Removal of Invasive Species*

  Invasive species like *Leucaena leucocephala* should be removed to control their invasion in the premises. Invasive species management is an essential part of conserving native floral species, as the introduction and invasion of exotic species can severely increase competition for native floral species. Controlling invasive species populations helps sustain local native diversity.

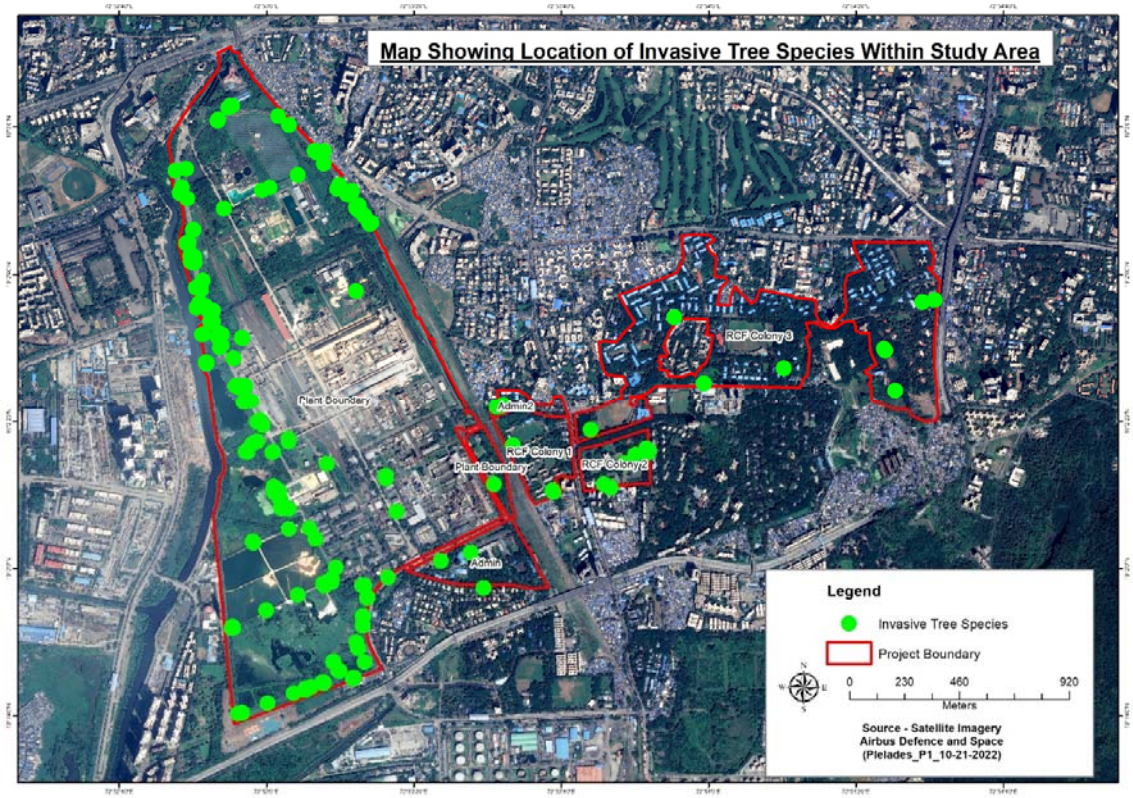


Figure 8 Map showing Invasive species location

2. Review of the plantation plan and methodology

- *Observations*

  RCF is working to restore and conserve biodiversity within and around the RCF campus through its R&D and Horticulture department. Numerous nurseries have been set up, and tree-planting initiatives are underway.

  According to CPCB/MPCB rules, as well as the additional conditions and demands of regional development, tree planting activity is still ongoing. planting trees that are native.

A few important observations made during the survey are highlighted: -

- A tree sapling was around 5 to 6 years of age.
- The pit size was 40x40x40 cm.
- The distance between the two trees was 2 m.

- *Suggestions*

  The selection of trees in the Plantation plan should be based on trees which more beneficiary to plants and internal activity. The amount of dust that spreads throughout the area is reduced due to the large leaves. On a tree's leaves, dirt, odors, and harmful gases like carbon monoxide, nitrogen oxides, and ammonia accumulate. Trees successfully filter out these toxic pollutants by absorbing them from their surroundings. Trees also contribute to reducing the negative effects of greenhouse gases on the surroundings by absorbing heat, reducing ground-level ozone levels, and releasing the breathing necessary for life.

  Trees bring lovely hues to their surroundings in a variety of ways, including the various shades of green visible in their leaves, the colors seen in flowering trees, and occasionally even the tree's bark.

  The following species are recommended for plantation purposes within Colony and admin areas:

Tree Species	Importance	Origin
Alstonia scholaris	Aesthetic	Native
Bauhinia purpurea	Aesthetic	Native
Cassia fistula	Aesthetic	Native
Ficus benjamina	Aesthetic	Native
Lagerstroemia speciosa	Aesthetic	Native
Magnolia champaca	Aesthetic	Native
Nyctanthes arbor-tristis	Aesthetic	Native
Saraca asoca	Aesthetic	Native
Senna siamea	Aesthetic	Native
Thespesia populnea	Aesthetic	Native
Delonix regia	Aesthetic	Exotic
Peltophorum pterocarpum	Aesthetic	Exotic
Plumeria alba	Aesthetic	Exotic
Roystonea regia	Aesthetic	Exotic
Acacia catechu	Economical	Native
Artocarpus heterophyllus	Economical	Native
Azadirachta indica	Economical	Native
Bergera koenigii	Economical	Native
Borassus flabellifer	Economical	Native
Cocos nucifera	Economical	Native
Mangifera indica	Economical	Native
Moringa oleifera	Economical	Native
Morus alba	Economical	Native
Phyllanthus emblica	Economical	Native
Psidium guajava	Economical	Native
Sapindus trifoliatus	Economical	Native
Syzygium cumini	Economical	Native
Tectona grandis	Economical	Native

Terminalia bellirica	Economical	Native
Terminalia catappa	Economical	Native
Ziziphus mauritiana	Economical	Native
Annona squamosa	Economical	Exotic
Tamarindus indica	Economical	Exotic

Table 11 List of trees recommended in Colony and Admin area

The following species are recommended for plantation purposes within the factory area:

Tree Species	Importance	Origin
Casuarina equisetifolia	Pollution tolerant	Native
Ficus elastica	Pollution tolerant	Native
Ficus hispida	Pollution tolerant	Native
Ficus religiosa	Pollution tolerant	Native
Ficus virens	Pollution tolerant	Native
Neolamarckia cadamba	Pollution tolerant	Native
Pongamia pinnata	Pollution tolerant	Native
Acacia auriculiformis	Pollution tolerant	Exotic
Kigelia africana	Pollution tolerant	Exotic
Monoon longifolium	Pollution tolerant	Exotic

Table 12 List of trees recommended in Plant area

3. Review Water Availability and Quality

- RCFL presently is self-reliant in meeting its requirement of the precious resources of Water and Electricity. The water required for the green belt is provided by the Treated water plant. RCFL is operating two Sewage Treatment Plants (STP) at the Trombay unit. Both plants together have the capacity to treat 45.50 MLD (Million Litres per Day) of Municipal sewage and produce 30 MLD (Million Litres per Day) of treated water for industrial use.

4. Recommendations for complying with the best practices of maintenance of green belts.

- *Avoid pruning of trees*

  Though pruning provides an aesthetic and neat look, it intensively subsides the overall function of the tree. Over-pruning may lead to stressed trees with a decline in health and reduced resistance to pests and diseases. Increased canopy cover can enhance the carbon sequestration rate and help in regulating micro temperature.
- *Management of the trees*

  Regular management of the trees is required to avoid poor growth. Also, additional inputs of fertilizers (NPK) and micronutrients should be supplemented on a regular basis, preferably, using green manure/compost/bio-fertilizers to provide better and eco-friendly results.
- *Conservation of species:*

  In case of further development where the clearing of trees will be involved, it is recommended to assess the species for their type, age, and overall health under the guidance of an expert. Native healthy species should be transplanted to nearby areas rather than just cutting them off.

5. Recommendations for plantation on the restored land/open spaces etc.

- *Promote plantation of Native Species:*

Native plants have adapted to the region and can grow in that particular condition, overall reducing the management cost. Additionally, native species support faunal species. The greenbelt can be enhanced by planting native species which can further improve the air quality of the surrounding area.

The presence of trees in the study area and their healthy growth indicate that they are receiving the necessary nutrients and soil conditions. It will be advantageous to continue planting the same species of trees.

Following are the native trees noted during survey: -

Sr. No.	Marathi Common Name	Scientific Name
1	Bherli mad	*Caryota urens*
2	Naral	*Cocos nucifera*
3	Umber	*Ficus racemosa*
4	Amba	*Mangifera indica*
5	Jambhul	*Syzygium cumini*
6	Kanchan	*Bauhinia variegata*
7	Shevga	*Moringa oleifera*
8	Kaduneem	*Azadirachta indica*
9	Shisham	*Dalbergia latifolia*
10	Sita Ashok	*Saraca asoca*
11	Bor	*Ziziphus jujuba*
12	Asana	*Bridelia retusa*
13	Karanj	*Pongamia pinnata*
14	Deshi badam	*Terminalia catappa*
15	Kala umber	*Ficus hispida*
16	Nagakunda	*Morinda citrifolia*
17	Putranjiva	*Putranjiva roxburghii*
18	Katesavar	*Bombax ceiba*
19	Taad	*Borassus flabellifer*
20	Pimpal	*Ficus religiosa*
21	Phanas	*Artocarpus heterophyllus*
22	Kavshi	*Firmiana colorata*
23	Peru	*Psidium guajava*
24	Behada	*Terminalia bellirica*
25	Belapata	*Hibiscus tilliaceus*
26	Awla	*Phyllanthus emblica*
27	Bahava	*Cassia fistula*
28	Kadamba	*Neolamarckia cadamba*
29	Khair	*Acacia catechu*
30	Shirish	*Albizia lebbeck*
31	Kashid	*Senna siamea*
32	Vad	*Ficus benghalensis*
33	Tuti	*Morus alba*
34	Thorla goonj	*Adenanthera pavonina*
35	Saptaparni	*Alstonia scholaris*
36	Rabracha vad	*Ficus elastica*

Sr. No.	Marathi Common Name	Scientific Name
37	Jamb	*Syzygium samarangense*
38	Suru	*Casuarina equisetifolia*
39	Bhend	*Thespesia populnea*
40	Dev savar	*Bombax insigne*
41	Akashneem	*Millingtonia hortensis*
42	Payar	*Ficus virens*
43	Dhaman	*Grewia amicorum*
44	Ral Dhup	*Canarium vulgare*
45	Katarlingad	*Crateva nurvala*
46	Ghol, Kapsi	*Trema orientalis*
47	Kadu kawath	*Hydnocarpus pentandrus*
48	Taman	*Lagerstroemia speciosa var. hirsuta*
49	Taman	*Lagerstroemia speciosa*
50	Son chapha	*Magnolia champaca*
51	Sag	*Tectona grandis*
52	Supari	*Areca catechu*
53	Kadipatta	*Murraya koenigii*
54	Bakul	*Mimusops elengi*
55	Parijaatak	*Nyctanthes arbor-tristis*
56	Vavala	*Holoptelea integrifolia*
57	Kukar	*Sterculia guttata*
58	Chiku	*Manilkara zapota*
59	F. benjamina	*Ficus benjamina*
60	Ritha	*Sapindus trifoliatus*
61	Bhokar	*Cordia dichotoma*
62	Surangi	*Mammea suriga*

Table 13 List of Native trees recommended

Site survey Photos


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Figure 9 Site Survey Images

D. Key deliverables

1) Report of the Assessment of the Green Belt

The Hard copy of the report has been submitted and the soft copy in PDF format is also provided in Pen drive.

2) Recommendations for upgradation with compliance for CPCB and SPCB Greenbelt requirements.

- Greenbelt refers to a buffer zone created beyond which industrial activity may not be carried on. This concept has developed through a long line of cases and today, greenbelts are present not only for the purpose of protecting sensitive areas to maintain ecological balance but are also be found in urban areas so as to act as a sink for the harmful gases released by vehicles and industries operating in the city area. In this regard, comprehensive Guidelines for Developing Greenbelts have been compiled by the Central Pollution Control Board [Refer Probes/75/1999-2000].
- Greenbelt is to be provided all along the boundary by planting tall, evergreen trees and the **total green area including landscaping area will be 1/3rd (about 33%) of the plant area**. This will include Lay down area which will be later on converted into Green area. Depending on the size, activity and environmental impacts of the industry; extent of land available, agro- climatic conditions, at least 10 m wide greenbelt of two rows of tall and evergreen plants

  The Central Pollution Control Board (CPCB) has guidelines for developing green belts. The guidelines include:

  1. 33% of the total land area should be kept as greenbelt
  2. The species selected should be capable of growing fast, wind firm, and long lived
  3. The density of the trees should be around 2500 plants per ha
  4. The spacing between the trees should be 1 tree per 4 sq.m.
  5. The average width of the green belt will be around 10 m
  6. There would be at least 3 layers of plantation
  7. Short trees (<10 m height) will be planted in the first rows (towards plant side) of the green belt
  8. Tall trees (>10 m height) will be planted in the outer row (away from plant side)
  9. Water loving species will be planted in the row nearest to the reservoir rim

3) Procured high-resolution satellite imagery.

Satellite imagery submitted in Pen drive.

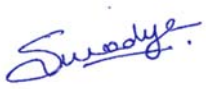
4) Google Earth file (.kml format)

Google Earth KML file of the Study area is submitted in Pen drive.

Abbreviations	Full form
AGTB	Above Ground Tree Biomass
ArcGIS	Aeronautical Reconnaissance Coverage Geographic Information System
cm	Centimetre
CO2	Carbon dioxide
COP27	27th Conference of the Parties to the United Nations Framework Convention on Climate Change
CPCB	Central Pollution Control Board
CR	Critically endangered
CSR	Corporate Social Responsibility
DD	Data deficient
EN	Endangered
ERDAS	Earth Resource Data Analysis System
FAO	Food and Agriculture Organization
GIS	Geographic information system
Ha	Hectare
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
KM	Kilometre
KML	Keyhole Markup Language
LC	Least concern
MLD	Minimal Liquid Discharge
MSAVI	Modified Soil Adjusted Vegetation Index
NDC	nationally determined contribution
NDVI	Normalized Difference Vegetation Index
NIR	near-infrared
QGIS	Quantum Geographic Information System
RCFL	Rashtriya Chemicals and Fertilizers Limited
SPCB	State Pollution Control Board
VU	Vulnerable
WD	Wood density

Project Name	Assessment of green belt and upgradation plan including restoration plan at RCFL premises, Chembur
Project Duration	March 2023 to October 2023
Client	Rashtriya Chemicals and Fertilizers Limited (Chembur)
Team	Mr. Saurabh Wadye, Analyst- Biodiversity Mr. Shailesh Kadam, Assistant Manager-GIS & CAD Mr. Mohammad Afsar Salmani, Specialist- Biodiversity Dr. Ninad Raut, Project Lead- Ecology and Biodiversity
Consultant	Terracon Ecotech Private Limited J/18, 1st floor, M.R. Colony, Relief Road, Santacruz (W), Mumbai 400054 www.terraconindia.com

Prepared by



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